COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

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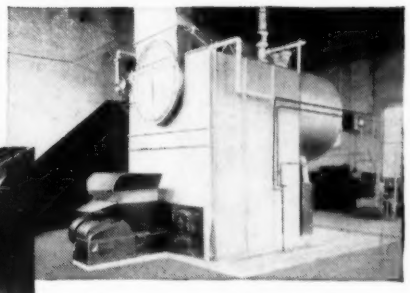
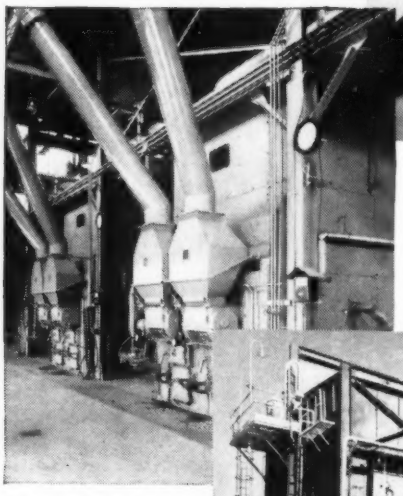
Looking up in furnace of Dunkirk boiler

Features of Dunkirk Steam Station

Experience with High-Pressure, High-Temperature Central Stations

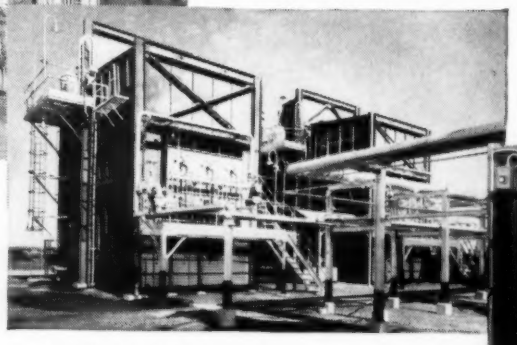


Installation for small plants . . . pressure up to 150 psi . . . capacity to 12,000 lbs. of steam per hr . . . adaptable to any fuel.

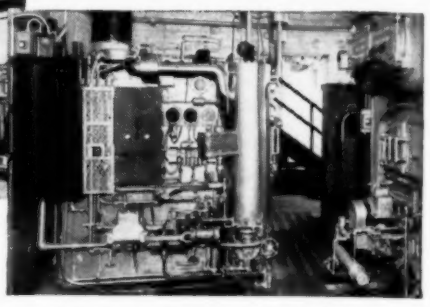


Planning to buy BOILERS ? . . . this year . . . next year

Installation for medium and smaller plants . . . pressure to 475 psi . . . capacity to 60,000 lbs. of steam per hr . . . suitable for any type of fuel.



Installation for larger plants . . . pressure to 1000 psi . . . temperature to 900 F . . . capacity to 350,000 lbs. per hr . . . any fuel or type of firing . . . indoor or outdoor type construction.



Installation for special conditions including very limited space . . . quick steaming (full capacity in 3 min.) . . . fully automatic operation . . . capacity to 6000 lbs. of steam per hr. . . . pressure to 300 psi. Ideal for intermittent load.

Sometime this year, or perhaps next, your company may decide to buy new boilers . . . to replace obsolete units . . . to meet increasing steam demands . . . or for a new plant. Whatever the time or circumstances, here's something it will pay you to remember. The operating cost of a boiler is a far more important consideration than its first cost. Why? Because the *annual* cost of fuel *alone* for the average boiler installation usually equals or exceeds the purchase price. And the normal life of a boiler should be 20 to 30 years, or longer.

Obviously, then, the operating economies accruing through the years from better design, construction or application, will quickly offset the difference in first cost between the cheapest boiler you can buy and the best the market affords. Here is one case where the old adage "the best is the cheapest" really applies.

In addition to having installed thousands of industrial boilers . . . in every size category from less than 100 horsepower up . . . Combustion has designed and built many of the country's largest utility power station boilers. And it is in this field — the manufacture of power on a large scale — that boiler design and construction are evaluated most critically in terms of economy of performance.

The fact that C-E Boilers have been selected to meet the exacting performance standards of so many of the nation's largest utility power stations is evidence of the quality of design and construction you can expect to find in any boiler, large or small, that bears the Combustion nameplate.

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ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT

COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

Vol. 22 **No. 4**

October, 1950

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GERALD S. CARRICK
Business Manager

ALFRED D. BLAKE
Editor

GLENN R. FRYLING
Assistant Editor

THOMAS E. HANLEY
Circulation Manager

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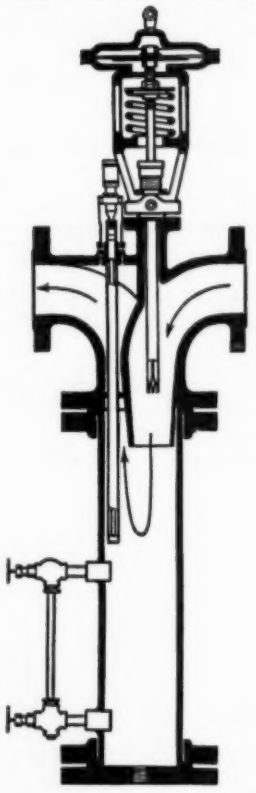
Self-Contained DESUPERHEATER



Cooling water completely atomized at all rates of flow . . . final steam temperature held closely . . .

Easily installed, the COPES Desuperheater holds the final steam temperature within plus-or-minus 5 degrees F., regardless of changes in initial temperature or rate of flow. Self-contained, it has no outside valve controlling flow. Complete atomization of the cooling water is assured by controlling its flow at the spray nozzle, across which pressure drop is held constant. Intimate contact of water and steam is at point of greatest turbulence in mixing chamber. Write for descriptive Bulletin 405-A.

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COMBUSTION

Editorials

Electric Power from Atomic Energy

An interesting commentary on man's capacity for wishful thinking is found in an account announcing the "discovery" of the so-called first practical method for direct conversion of atomic energy into electricity. Published in one of America's most reputable newspapers and subsequently repudiated by an outstanding science reporter on the same paper and by the Atomic Energy Commission, the report in itself still merits thoughtful consideration.

In the struggle for control over nature, men have long dreamed of finding some simple way of obtaining useful power by unlocking the binding forces that apparently hold matter together. Study in the field of thermoelectricity began in 1821 with the discovery by Seebeck that an electric current flows continuously in a closed circuit of two dissimilar metals when the junctions of the metals are maintained at different temperatures. However, the potential difference of a single thermojunction is but a few millionths of a volt per degree difference in junction temperatures. In 1888 Arthur Rust of England constructed a "Magnopile" consisting of a coke-fired furnace in which 6000 thermo elements were mounted on a casing located within the furnace. This arrangement was said to have produced an electromotive force of 96 volts with a resistance of 11.5 ohms, and in the words of the inventor, "A Magnopile. . . will, in the future, be a commercial success."

From the foregoing it can be seen that the direct conversion of heat energy to electricity is not new and that in the days before the dynamo became a commercial success, thermoelectricity was seriously considered as a source of power. Today it still remains a dream, though immersed in the intriguing speculation that often is attached to anything which may be connected with atomic energy.

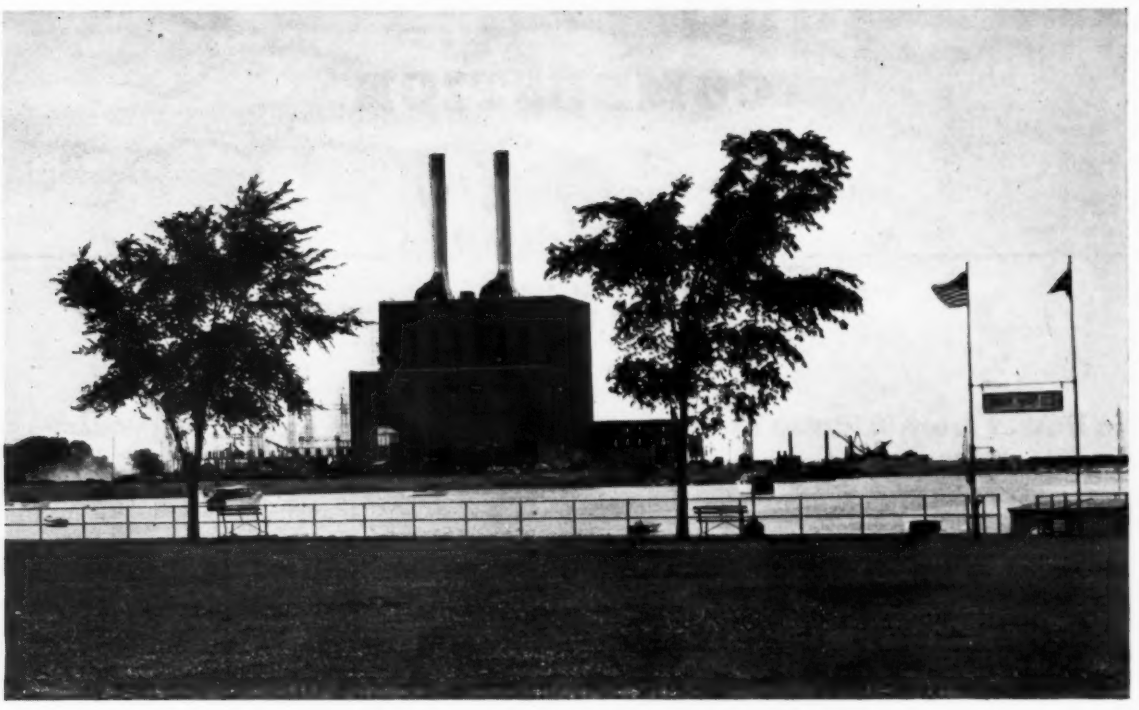
What many fail to recognize about atomic power is that developments which will lead to its application in commercial service also are likely to increase the efficiency of stations operating on the steam cycle. For example, materials capable of withstanding extreme temperatures that may be anticipated in some atomic processes also should be available for use in conventional central stations. Or at the other end of the thermodynamic cycle, if methods are devised to make efficient use of low-head heat for atomic power plants, it is to be expected that they will also be suitable for converting to useful energy some of the heat now unavailable and discharged to rivers and bays through condenser circulating water.

Steam Generator Ratings

There is some indication of a trend toward expressing capacities of large modern steam generating units in terms of the end-product, namely, the kilowatt rating of the turbine-generator served. This, of course, is applicable only to the unit system of one boiler per turbine. It is convenient in presenting the overall picture and has merit for certain uses, but for the purpose of comparison between units it has limitations analogous to those of the more widely used thousands of pounds of steam per hour, which, to be strictly comparable, require corrections for steam conditions and feedwater temperature. As a basis for preliminary plant design the latter expression is directly determinable from the turbine-generator rating and water rate.

On the other hand, the increasing use of reheat introduces some confusion when comparing the size of units operating on the reheat and the non-reheat cycles, and for such cases the kilowatt rating has much to commend it.

Much depends upon the purpose for which the terms are employed, although the only true measure of capacity is the heat input to the water and steam, expressed in million Btu per hour. This is a term employed to some extent in central station practice, although perhaps less readily comprehended.



Exterior view of station from Dunkirk Yacht Club

Features of Dunkirk Steam Station

By R. P. MOORE

Niagara Mohawk Power Corporation

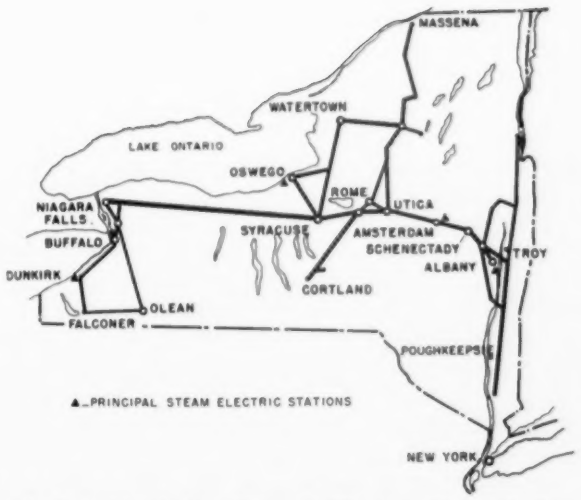
This new station, located on the shore of Lake Erie in the western part of New York State, contains two 80,000-kw single boiler-turbine-generator units operating under throttle conditions of 1450 psig, 1000/1000 F. Some of the engineering thinking underlying the decisions to adopt reheat and to continue innovations found successful in other plants of the Niagara Mohawk Power Corporation is outlined in the article, which also includes descriptions of the principal station equipment.

THE Niagara Mohawk Power Corporation serves a large portion of New York State and includes within its scope of operations the important industrial cities of Buffalo, Syracuse, Albany, Utica, Schenectady, Niagara Falls, Troy, Rome and Watertown. Just prior to World War II the steam power facilities of the system were augmented by the addition of an 80,000-kw unit to the Huntley Steam Station near Buffalo and by the construction of the Oswego Steam Station located on Lake Ontario about thirty-five miles northwest of Syracuse. Two 80,000-kw single boiler-turbine-generator units were originally installed in the Oswego station (1, 2)*, a third of like capacity was recently placed in service, and a fourth incorporating the reheat cycle is being installed.

An expansion program now under way provides for the building of two additional steam stations, one at Dunkirk on the west and the other near Albany in the eastern area of the system, each of 160,000-kw capacity initially. When the units now on order are placed in operation, system capacity will be just over two million kilowatts, of which about half will be generated in hydro plants and the remainder in steam plants.

System growth, particularly in the post-war years, required added generating capacity in the Western Division. For many years there has been a 115-kv multi-circuit transmission loop connecting Huntley Steam Station near Buffalo (which is also tied electrically to the hydroelectric plants in the Niagara Falls region) to Dunkirk at the extreme western end of the system and to Olean, about seventy miles south of Buffalo. By the end of World War II the industrial load in the Dunkirk area had grown to the point of taxing the 80,000-kw capacity of this transmission loop. Location of a new steam station in the vicinity of Dunkirk therefore offered the attractive possibility of unloading the transmission loop in one direction and loading it in the other, to meet the increasing power demands in the Dunkirk and the Buffalo areas.

* Numbers in parentheses refer to Bibliography at end of this article.



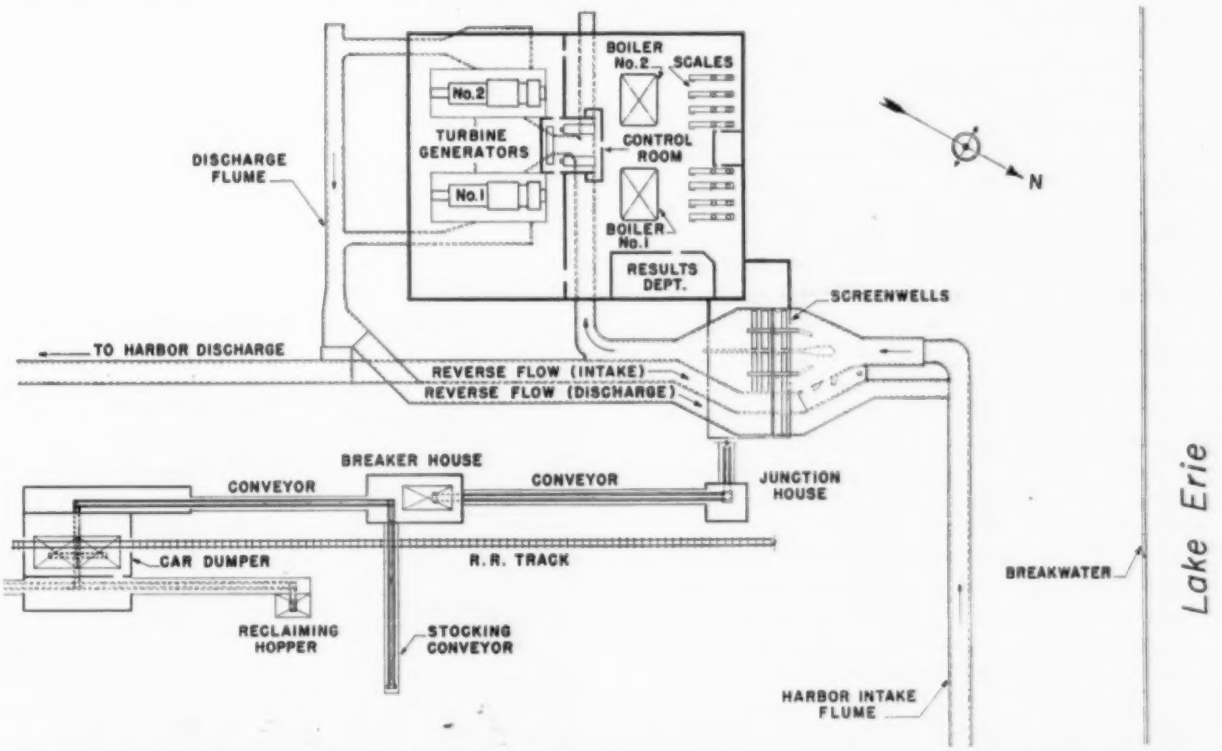
Principal transmission lines of Niagara Mohawk System

For reasons of available cooling water and the possibility of obtaining water-borne fuel, a lake-side site was preferred. The one finally selected was located in Dunkirk harbor and was under water at the time of the start of construction. Along with the advantage of being located favorably with respect to existing transmission facilities (to tie in the new station about a mile of new lines was required), the Dunkirk site offered unusually good foundation conditions, for rock strata extended to within a few feet of the surface. In addition, ample condenser cooling water is available, averaging 50 F throughout the year with occasional maximum readings of 79 F. Since the city of Dunkirk is served by five railroads, coal may be received by rail; future delivery by water is also possible.

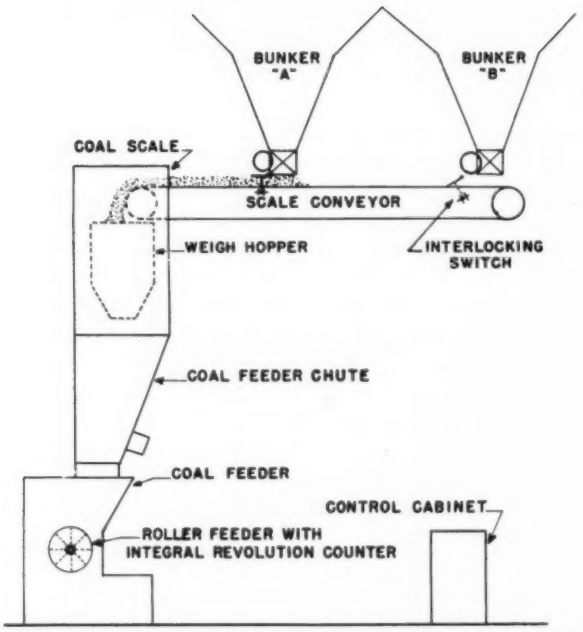
Niagara Mohawk engineers had been attracted to the potential economic advantages of the reheat cycle for a number of years, and consequently studies along this line were to be expected in establishing the steam conditions for the new Dunkirk Station. Tied to the question of reheat was the successful operating experience, dating from December 1940, of single boiler-turbine-generator units at Oswego Steam Station. Some of the thinking underlying the decision to adopt the reheat cycle and turbine throttle conditions of 1450 psig, 1000 F, 1000-F reheat was explained by the author (3) at the 1949 A.S.M.E. Annual Meeting in a paper comparing costs of reheat and non-reheat installations of single boiler-turbine-generator units of 100,000-kw capability. The decision was also influenced by the availability of a new simplified design applicable to reverse-flow reheat turbines and by increasing fuel costs. The latter had more than doubled over the 1939–1947 period, thereby making even more attractive the lower heat rate of the reheat cycle. To compensate for the slightly higher reheat investment, it is planned to operate Dunkirk Steam Station for its first five years at high annual plant factors, making possible an accelerated return on the added investment.

Steam Generating Units

The two steam generating units, built by Combustion Engineering-Superheater, Inc., are of the bent-tube, radiant-reheat, single-pass type and have water-cooled furnaces, Elesco two-stage superheaters and interstage reheaters, fin-tube economizers, and Ljungstrom air preheaters. They are fired by tilting tangential burners, under automatic control and supplied by C-E Raymond bowl mills. Design pressure is 1650 psig, with superheater outlet conditions of 1492-psig, 1000 F primary steam, and 389-psig, 1000-F reheat steam. At maximum continuous rating each unit generates 670,000 lb per hr of primary steam, and there is a reheat flow of 585,000 lb per hr. Calculated draft loss is 6.75 in., and calculated overall efficiency under these conditions is 89.3 per cent.



Plot plan of Dunkirk Steam Station, showing provisions for recirculating condensing water and coal-handling facilities



Schematic arrangement of control regulating raw coal feed

with incoming feedwater at 455 F and 100 F, 30 per cent humidity air. Vulcan automatic sequentially operated air soot blowers are installed.

Design is such that the steam generating units can operate satisfactorily with coals having the following ranges of proximate analysis:

Volatile matter	19–37 per cent
Moisture	2–14 per cent
Ash	7–14 per cent
Sulfur	1.5–3.5 per cent
Heat content, as fired	11,500–14,000 Btu per lb
Ash softening temp	2050–2450 F
Ash liquid temp	2300–2550 F
Hardgrove grindability	55–90

Each steam generating unit is served by four bowl mills, and pulverizer capacity of three of them is capable of maintaining full steam output on each unit. For regulating raw coal feed, each pulverizer is equipped with automatic control. To insure delivery of coal from the main bunkers to the pulverizers and to start operation of vibrators in case of flow interruption, the coal feeders are furnished with a special contact which indicates the passing of each half revolution. Based on a design originally developed for Huntley Steam Station in the early 1930's, the electro-mechanical device is tied into the coal scale, with its known capacity per dump, and the coal feeder roll, which likewise passes a known quantity of coal per revolution. In case the coal is "hung up," the mechanism automatically starts operation of the vibrators in the coal feeder chutes.

Steam temperature control of both the superheaters and reheaters is by means of tilting burners supplemented by air-flow controllers used to anticipate steam temperature changes by variation of gas flow to the superheater. For control under emergency or abnormal conditions spray-type desuperheaters are also supplied.

To provide a reliable method of assuring ignition on the pilot torches of the steam generating units, an indicator has been developed which will show whether the light fuel oil has been turned on to its ignitor and whether, within a short period of time, ignition has been obtained. The apparatus lends itself to remote control indication at the centralized operating point.

Reheat Turbine

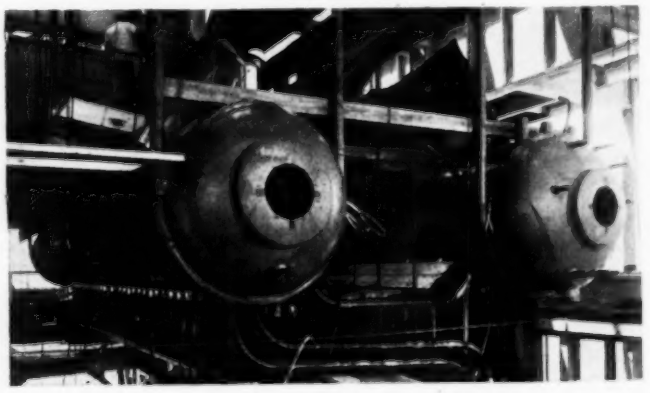
The evolution of the reheat design has produced a turbine as simple in form and application as a non-reheat unit. The units at the new Dunkirk Station are 3600-rpm, tandem-compound, double-flow machines, each having a total of 23 stages with eight stages in the high-pressure section, ten in the intermediate section and five in the double-flow low-pressure section. They will operate with steam at 1450 psig, 1000/1000 F.

Referring to the cross-section, it is to be noted that high-pressure steam enters the turbine shell at mid-section and travels forward (away from the generator). It is exhausted to the reheater at the forward end of the turbine adjacent to the No. 1 bearing standard and re-enters from the reheater immediately adjacent to the point at which the high-pressure steam is admitted. Thus only one portion of the turbine shell is subjected to the high temperature of the initial and resuperheated steam. This eliminates any severe temperature gradients that might otherwise exist. It also moves the highest temperature portion of the turbine shell and shaft away from the bearings and water seals.

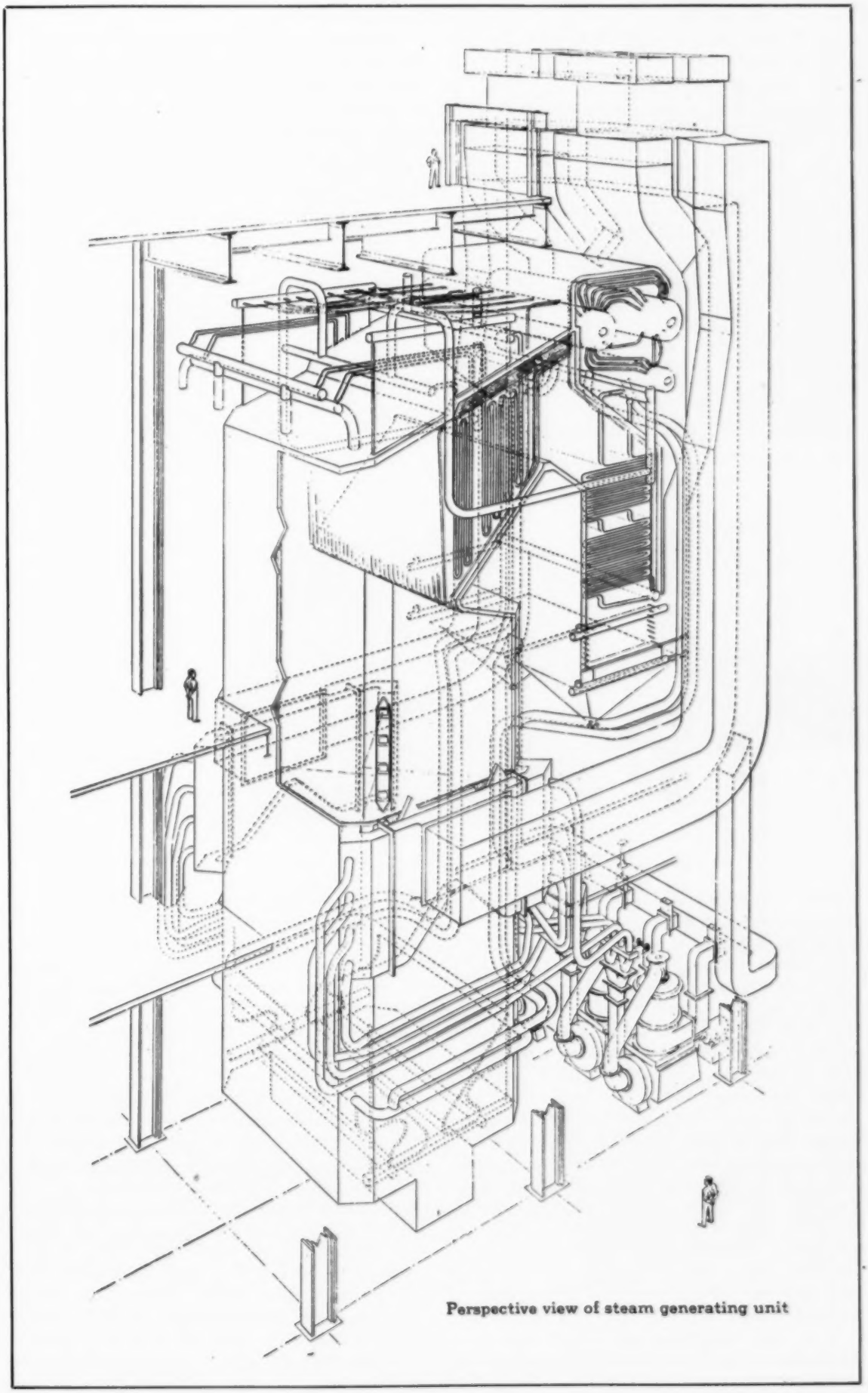
Foundation and station space required for this type unit are essentially the same as for a unit of similar rating without resuperheating. This, together with the fact that the turbine does not require an additional cylinder to accommodate resuperheating, minimizes the capital investment.

The shells are symmetrical, relatively uniform in thickness, and have circumferential extraction passages. This construction minimizes distortion and misalignment, and is materially conducive to long turbine life with freedom from detrimental effects of high temperatures with a certain amount of load swings. The double-shell construction minimizes the wall thickness and size of the horizontal flange. Guides are provided between the inner and outer shells and arms between the shell and front standard are designed to take care of expansion without creating misalignment. The crossover, middle bearing housing and sections exposed to considerable temperature differentials in the fabricated exhaust hood are designed with flexible joints so the various sections might breathe or expand freely without obstruction from mating parts.

Nozzle partitions are machined from solid chrome-



Showing suspension of two upper boiler drums



Perspective view of steam generating unit

iron alloy and incorporated into the diaphragm either by welding or a "cast-in" process.

The rotor is a solid alloy forging machined to form the shaft, wheels, bearing journals and coupling flange, the wheels being machined to receive the dovetails of the buckets. This makes for a smooth running rigid rotor with normal operating speed well below the critical speed.

Radial spill strips are inserted in the diaphragms or shells outside the periphery of the bucket covers. This type of packing permits axial movement without affecting efficiency. All the diaphragm and high-pressure packing rings are spring backed allowing freedom of movement if at such time the shaft might have excessive runout or vibration.

Water packings are employed to seal the turbine shaft and casings for pressure or vacuum conditions from atmospheric pressure.

Control Requirements

A turbine for the resuperheat cycle requires those controls customarily used on a non-reheat turbine plus an intercept valve, together with its control. This intercept valve is located close to the turbine in the line returning the steam from the reheater. Its sole purpose is to prevent the turbine speed from reaching 110 per cent and thus tripping the emergency governor when a sudden loss of all or all but a small portion of the electrical load occurs. If it were not for the intercept valve, the unit, upon loss of electrical load, would rise in speed and trip the emergency stop valve, even though the main steam control valves were closed, due to the continuing flow of the steam stored in the reheater and associated piping through the low-pressure section of the turbine.

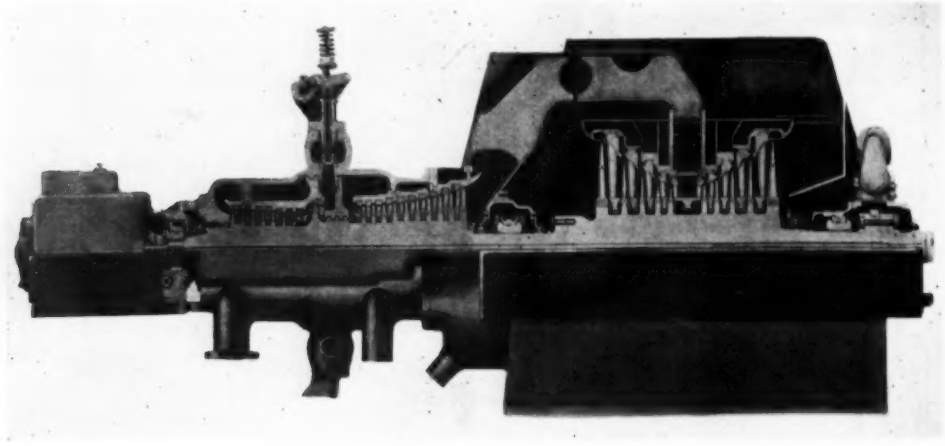
The intercept valve is controlled by the pre-emergency governor, located in the front standard, which is designed to operate the valve through full stroke with a change in speed of approximately four per cent.

Although only an intercept valve and a governor need be added to the usual turbine controls for a resuperheat turbine, the operation and control of a resuperheat installation involves more problems than this alone would indicate. There are two major problems: first, protection of the reheater upon sudden loss of load or during starting; and second, protection of the exhaust portion of the turbine and the condenser against overheating during starting or operation at no load or light loads of a few thousand kilowatts.

The first of these is being met on modern installations by automatic provision actuated by switches on the turbine for controlling the fires when all or most of the load is suddenly lost. By adequate indicating means, the boiler operator can be informed of the load conditions on the turbine following the loss of load from which the subsequent operation of the boiler can be determined.

The protection required to prevent overheating of the exhaust and of the turbine depends upon the boiler characteristics and the operating cycle. For short periods of operation at no load or light loads, it is probable that no protection will be necessary. For prolonged periods of operation at no load or light loads, provision for protection should be made if the characteristics of the boiler are such that there is a temperature rise of any magnitude in the steam passing through the reheater. At light loads, after steady conditions have been reached, it is reasonable to assume that the exhaust of a resuperheat turbine will operate hotter than a similar non-reheat turbine. This will be by the number of degrees temperature rise of the steam passing through the reheater, provided vacuum and temperature conditions are such that the exhaust of the non-reheat unit is saturated or superheated. Thus, a temperature rise of 50 deg through the reheater may cause the exhaust end of a resuperheat turbine to operate at no load approximately 50 deg higher than the exhaust of a similar non-reheat unit supplied with steam at the same initial conditions. An increase in exhaust temperature of even this magnitude is considered undesirable. To overcome this condition, desuperheating of the steam is required. This is accomplished by desuperheating in the turbine crossover just ahead of the low-pressure turbine by use of automatically controlled water sprays.

If a resuperheat unit, running at full load, should suddenly lose all or nearly all of its load, the speed will rise enough to close the intercept valve and the unit will continue to operate at a speed sufficiently high to keep the intercept valve closed. Under this condition, high-pressure steam passes through the high-pressure turbine under control of the governor control valves and exhausts to atmosphere through the reheater safety valves. This condition is corrected by moving the governor speed control down to restore the unit to normal speed. When



Cutaway section of tandem-compound, double-flow reheat turbine

the speed drops, the intercept valve will reopen and operation becomes normal.

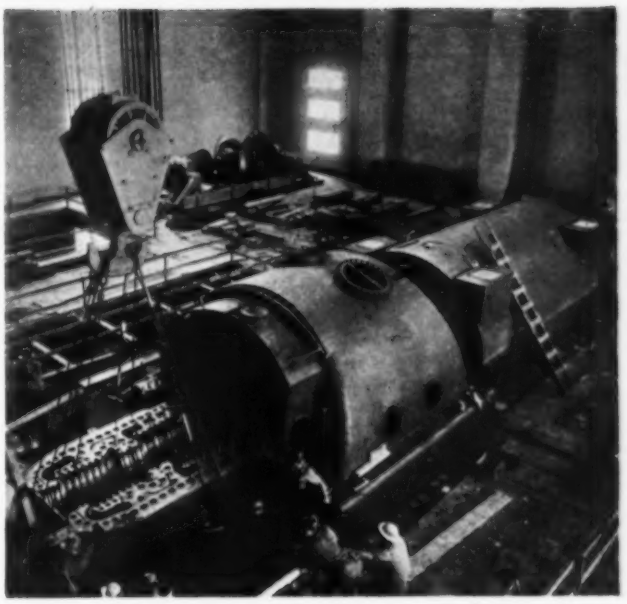
In a resuperheat installation, the question arises concerning the starting and permissible rate of load change as compared with a non-reheat unit. Considering only the turbine, the time to start and bring a resuperheat turbine to speed should not differ from that for a non-reheat turbine of comparable size and design. Similarly, when desuperheating of the reheated steam at light loads is as accurate as the control of initial temperature, the maximum rate of load change is the same for a resuperheat as for a comparable non-reheat turbine.

Condensing System

Each turbine exhausts to a Worthington 50,000-sq ft single-pass condenser, containing 7800 Admiralty metal tubes, No. 18 BWG, 28-ft long and $^{7}/_{8}$-in. OD, through which cooling water is pumped at the rate of 79,200 gpm.

Condenser air evacuation for each unit is performed by a Worthington Type RDV motor-driven, piston-type vacuum pump. Steam-jet air ejectors are also installed, but normal operation is expected to be with mechanical pumps, which are adapted to remote control. Other than the emergency jets there are no steam driven auxiliaries in the plant.

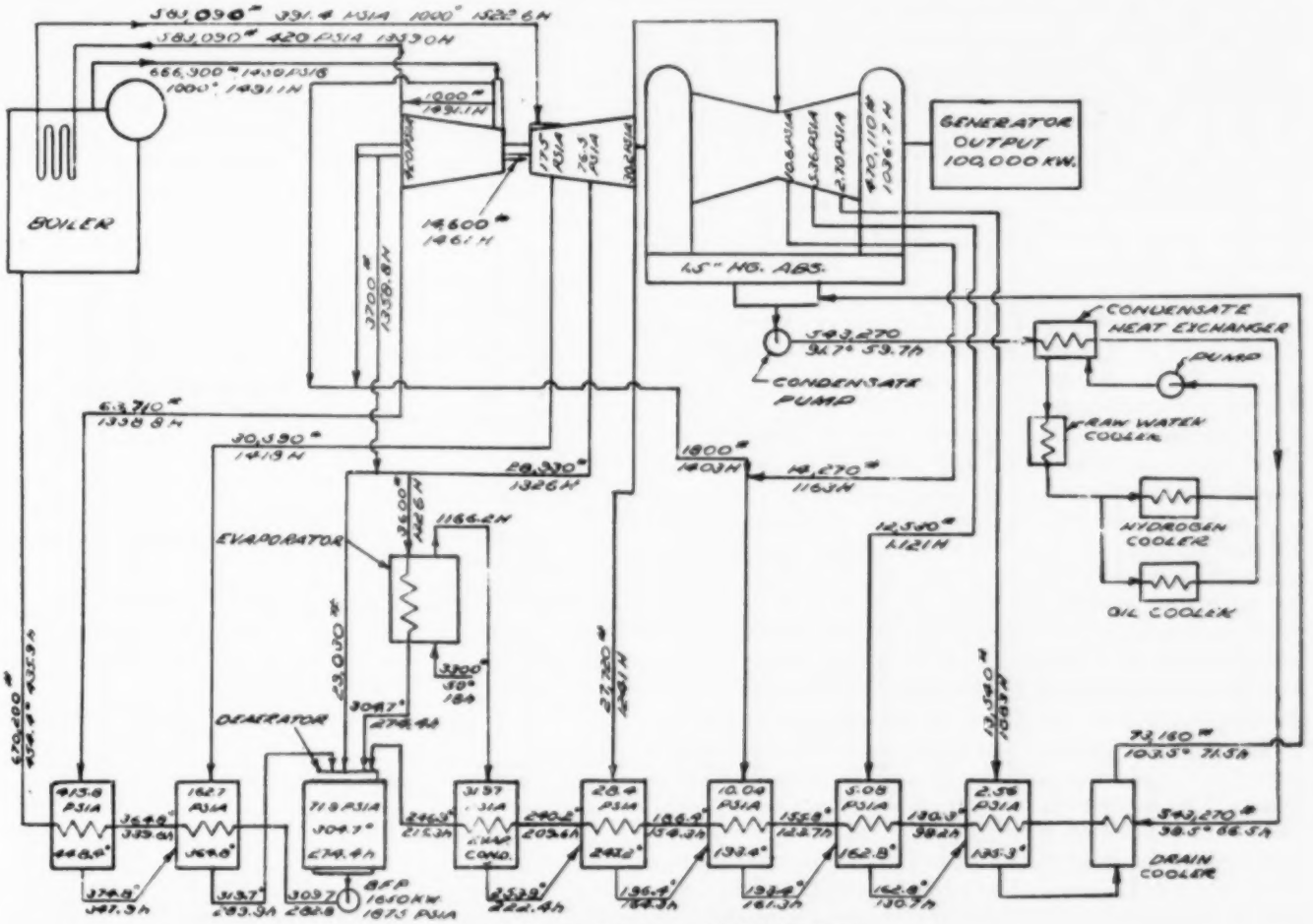
Condensing water from Dunkirk harbor is supplied by two circulating water pumps per unit, each having a rating of 40,000 gpm at a total head of 18.3 ft. Provision is made to recirculate condensing water to prevent the formation of ice on the screens and to reverse its direction of flow to melt any large quantities of ice tending to clog the intake tunnels.



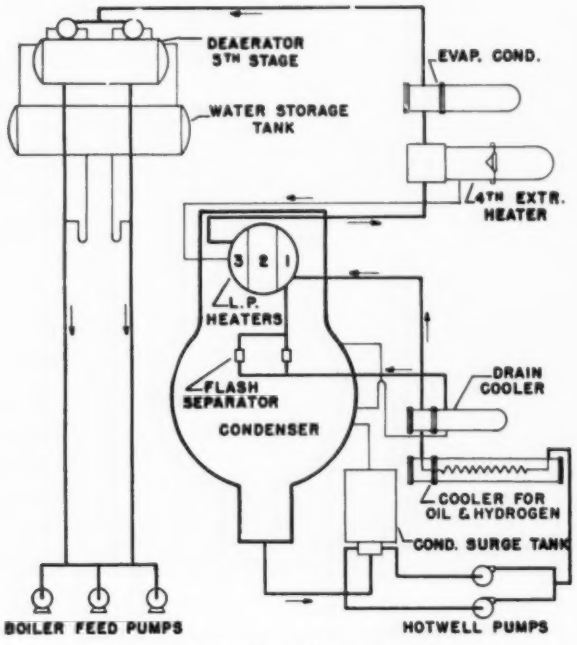
Lowering into place bottom half of high and intermediate-pressure reheat turbine casing

Feedwater Cycle

Seven extraction feedwater heaters raise the temperature of the condensate to its final level of 455 F at the economizer inlet. Heaters Nos. 1, 2 and 3 are unique in



Heat balance diagram—100,000-kw load



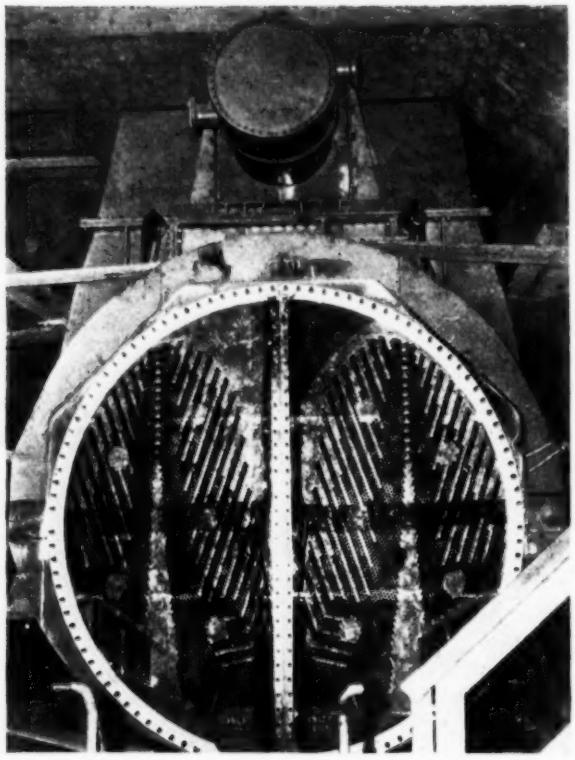
Low-pressure section of regenerative cycle

that all three are located in the same cylindrical shell built in the neck of the condenser. Furnished by the Alco Products Division of American Locomotive Company to the design of the Niagara Mohawk engineering department, this combination of three heaters in one unit offers the advantage of short, compact, valveless piping from the low-pressure turbine bleed stages completely within the turbine exhaust. More details and the arrangement of the low-pressure section of the cycle are shown in the schematic arrangement. As indicated, provision is made to have a positive suction head at all times on the boiler feed pumps. This is accomplished by having a cold water storage tank located below the deaerator (5th extraction heater) and attached to the suction line through a U-tube connection, which prevents the hot water entering the cold water tank. In case of flashing in the deaerator, the cold water flows into the pump suction (4).

Bailey three-element feedwater control, based on drum-water level, is installed to regulate the fluid drives of the three motor-driven Byron-Jackson 11-stage, barrel-type feedwater pumps for each unit. Each of these pumps has a total dynamic head of 1664 psig at 3500 rpm, and two units have sufficient capacity to supply one steam generating unit at full load.

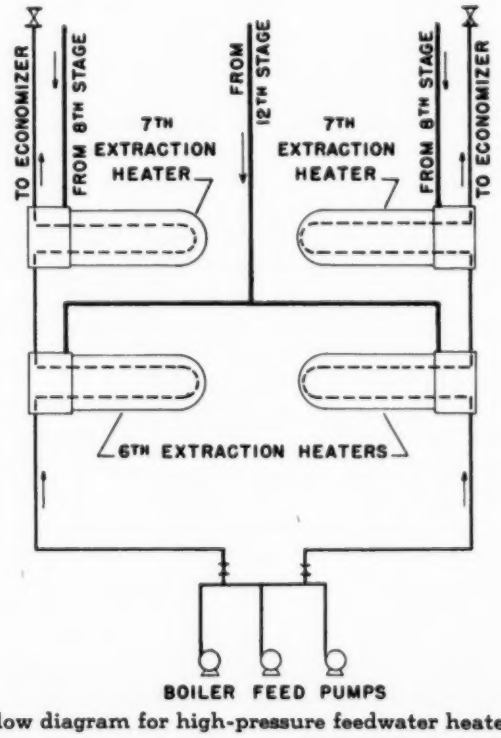
The high-pressure feedwater heaters are of the closed, desuperheating, internal drain-cooler type, supplied by Alco Products Division of American Locomotive Company, and are installed in duplicate in parallel. It is of interest to note that the bled steam for the seventh-stage extraction heater is taken directly from the reheat piping connecting the exhaust of the high-pressure end of the turbine to the reheat section of the steam generating unit.

Design of the main steam piping was influenced by a series of model tests made by the M. W. Kellogg Company. The superheater header of the steam generating unit is suspended on spring hangers, and the 124 tubes which feed the header are made structurally a part of the main steam piping. This provides additional flexibility for expansion and reduces the magnitude of the reactions at the turbine. From an analytical viewpoint,



Condenser showing inlet tube sheet and "three-in-one" Alco heater located at the top of the photo in the neck of the condenser

the system is complicated by the addition of a partial restraint at the turbine throttle valve and by the use of two turbine leads emerging from the valve. The model tests for Dunkirk, which were described in an article by L. C. Andrews of Kellogg (5), enabled the determination of (*a*) the thrusts and moments exerted by the piping system upon the equipment connected to it, (*b*) the stresses created by the attendant reactions within the



Flow diagram for high-pressure feedwater heaters

pipes themselves and (*c*) the deflections of the various portions of the system, the last-mentioned being of assistance in designing pipe hangers.

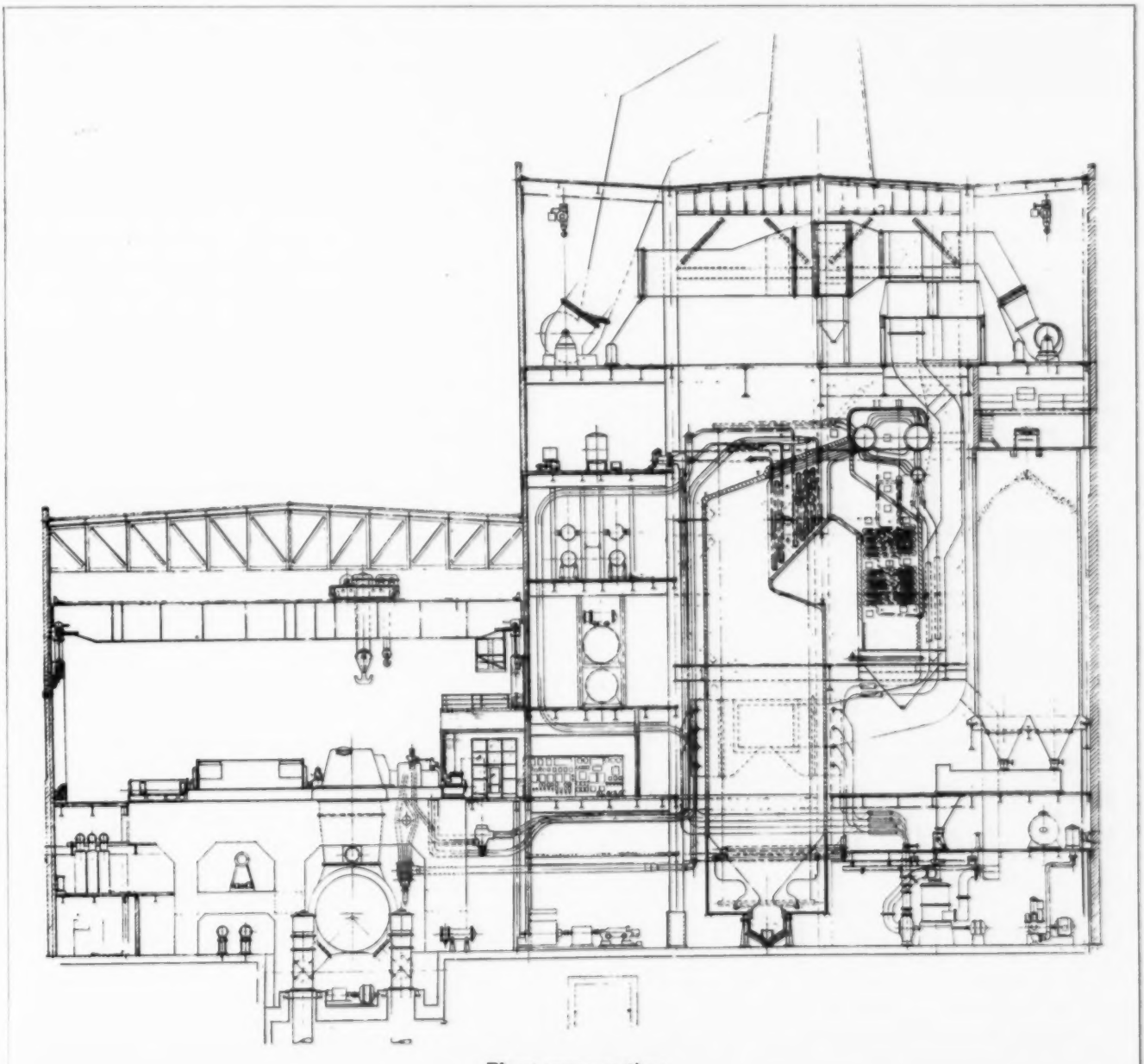
Draft System

As shown in the plant cross-section, both the forced and induced-draft fans are located in the upper levels of the plant structure. Two forced-draft fans are installed per unit; they are of American Blower manufacture, operate at constant speed, are controlled through inlet vanes, and are each rated at 112,000 cfm at 11.5-in. WG. There are also two induced draft fans per unit, manufactured by Buffalo Forge Company and motor driven through Dynamatic variable-speed magnetic couplings. Each I.D. fan has a rating of 180,000 cfm at 14-in. WG. They discharge into a Gunite-lined steel stack extending 150 ft above the roof of the station. Fly ash collection is by means of Aerotec cyclone-type mechanical collectors.

Coal Handling

Coal handling will follow much the same practice successfully employed at the Oswego Steam Station and described by J. N. Ewart at the 1949 A.S.M.E. Annual Meeting (6). Initially coal will be received by rail, handled through a car dumper, and transported by conveyors to the station, passing through a Bradford breaker, or placed in storage by means of a stocking conveyor equipped with a telescopic discharge chute. Bulldozer-carryall units are to be used to stock the coal, laying and compacting it in layers about 10-in. thick. Reclaiming will likewise be by means of bulldozer-carryall units.

The climate along the shores of Lake Erie is such that the emptying of coal cars in the winter time presents quite a problem, as a result of the coal freezing in the cars. Experiments have been conducted at the Huntley Station which indicate that the use of hot water sprayed on the cars is an excellent way of separating the coal from the car sides and bottom with the minimum of man-



Plant cross-section

Dust collector inlet

power. This scheme will be developed and installed at the Dunkirk Steam Station for use in connection with the car dumper.

A car to be thawed will be spotted over a basin and hot water will be sprayed onto the sides at the top to run down over the surface and also on the hoppers at the bottom. This will melt the coal adjacent to the steel, but a few inches in it will remain frozen, resulting in large chunks of frozen coal. To take care of these large chunks, the hopper under the car dumper is equipped with single roll crushers with long teeth which literally reach up into the hopper and chew up the chunks. The spray water will be heated by building heating steam and after falling off the cars, where experience indicates it only loses about 20 degrees of temperature, it will be reheated and circulated.

Centralized Control Room

On the basis of highly successful experience at the Oswego Steam Station, centralized control is also being installed at Dunkirk. The control room is located on the main operating floor in an area between the boilers and turbines. Each of the single boiler-turbine-generator units has its own mechanical control board, while a single electrical control board, at right angles to the two mechanical boards, serves the function of regulating electrical output. The location of the control room permits easy and rapid access to plant equipment as well as serving to coordinate station operations. In a paper presented at the 1950 A.I.E.E. Winter Meeting, J. A. Lind and J. M. Geiger (7) explained the underlying idea of centralized control in these terms: "A conception, believed to be original, was that of a 'straight-line organization' for each unit, originating with a 'unit operator' who would be in a position to supervise all operations of one boiler-turbine-generator unit. Normally he would control input to suit output, but he would also control output to not exceed the capacity of the unit and its associated equipment." The unit operators have control of practically all station functions except those relating to start-up, and there is no formal separation of mechanical and electrical functions. The latter makes it possible for the same operator to handle either the electrical switchboard or mechanical control boards.

Electrical Features

The two generators each have a rating of 100,000 kva at 0.8 p.f. and $^1/_2$-psig hydrogen, and 120,000 kva at the same power factor and 20-psig hydrogen. Each of the generators is connected solidly to a 110,000-kva forced-air-cooled three-phase transformer. A main 115-kv bus is provided with a sectionalizing breaker, and a 115-kv transfer bus is provided for the four outgoing transmission circuits. The principal purpose of the transfer bus is to assist in sleet melting.

Following previous practice of the Niagara Mohawk system, each alternating current generator may be uncoupled from the turbine and used for synchronous-condenser operation. When this is done the direct-connected exciter operates as a motor supplied from a 500-kw direct-current generator, and the a-c generator can be accelerated and paralleled with the system to act as a synchronous condenser for system voltage control.

Station auxiliaries are supplied normally by one 6000-kva transformer connected through disconnects to the 13.8-kv generator conductors. Each transformer supplies a single 2400-volt bus, from which all the auxiliaries for one unit are fed. A number of 600-volt unit substations are located about the station, each consisting of two 500-kva transformers and associated switchgear for supplying the smaller motors and other facilities.

Communications facilities consist of telephones, code-call equipment and a public address system. Code call is performed by dialing at the telephones. The public address system has microphones at strategic locations, any one of which will sound all of the speakers located in and around the station. Distinctive coded signals for fire alarm, first aid and emergency are also carried over the public address system. In case of power failure to the speakers, communication can be continued by voice energy through microphone hand sets.

Design for the entire project was carried out by the engineering department of the Niagara Mohawk Power Corporation. Construction supervision was under the direction of Stone & Webster Engineering Corporation.

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ASME Fall Meeting

THE American Society of Mechanical Engineers held its Fall Meeting in Worcester, Mass., September 19–21, at the Hotel Sheraton. Some fifty papers were presented in the fields of heat transfer, management, textiles, machine design, plastics, materials handling, power, fuels, hydraulics and gas turbines. Only those dealing with steam power and gas turbines are here reported.

Ultrasonic Flaw Detection in Pipes

In determining flaws in the annular cross-section of high-pressure piping, normal ultrasonic testing employing longitudinal waves does not provide adequate inspection. According to **C. D. Moriarity** of the General Electric Co., this is especially true where it is suspected that there are radial-type flaws extending axially, such as radial cracks or folds. Since this sort of physical orientation will weaken a pipe subject to internal pressure, there is need for a workable method to detect this type of flaw.

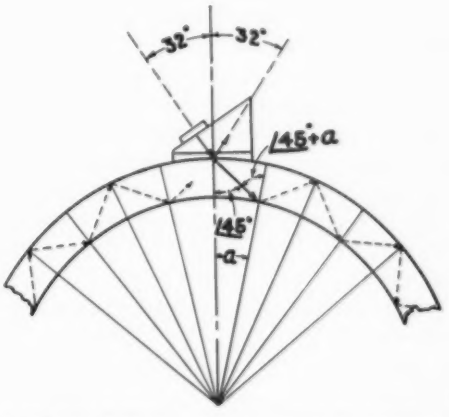

Fig. 1—Propagation of shear waves in round pipe.

By using ultrasonic shear waves, in which particle motions are normal to the direction of travel, it is possible to penetrate the metal to find subsurface flaws. As shown in Fig. 1, the shear wave, in a sense, ricochets off the inner and outer pipe wall boundaries in its circumferential travel. Actually, of course, the sound path is a continuously diverging beam, the centerline of which is represented in the diagram. The shear wave is converted by means of a receiver crystal to a longitudinal wave which may then be reproduced electrically in an oscillogram. Fig. 2 illustrates the reason for low magnitude receiver pickup of sound after one complete revolution in a pipe without a flaw. The shear wave is

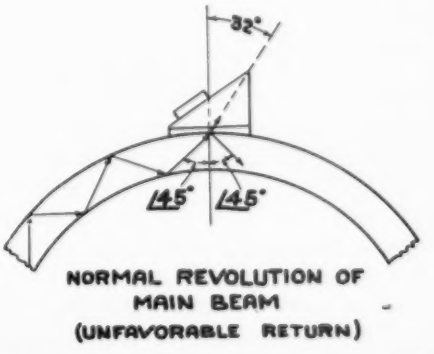

Fig. 2—Illustration of reason for low magnitude receiver pickup because sound is not directed at receiver crystal.

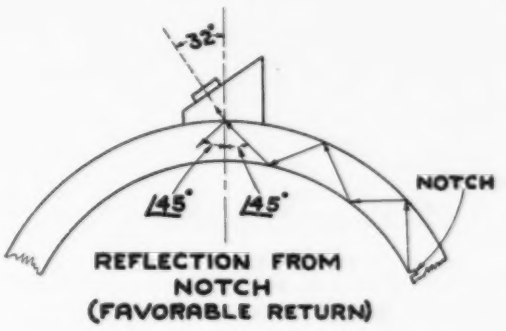

Fig. 3—Illustration of reason for high magnitude receiver pickup because reflected sound is directed at receiver crystal.

approaching the crystal from the rear, which is the most unfavorable direction for electrical reproduction. On the other hand, as shown in Fig. 3, a reflection from a flaw, such as a notch or other defect, traverses the same path as the incident shear wave, except in the reverse direction. Thus it strikes the receiver crystal at a favorable angle for reconversion into a longitudinal wave. Because of this favorable condition the intensity of the reflection is greater than that made by the main beam making a complete revolution and passing under the crystal in an unfavorable direction.

As a reference point in ultrasonic testing of pipes by means of shear waves, a five per cent notch has been adopted. This has a depth approximately five per cent of the nominal wall thickness, a width not less than twice the depth, and is cut in the surface of the pipe to be tested. The maximum ultrasonic indication obtainable from this notch is known as the five per cent indication. Upon exploration of the pipe by ultrasonics, any defect indication on the screen, obtained under the same test conditions, that exceeds the magnitude of the five per cent indication requires the removal of that flaw. Such defects as die marks, tight-scale breaks and shallow folds do not come up to this value and therefore require no additional investigation.

Present limitations of the test include the smallness of pipe that may be tested and the fact that the nature of the flaw cannot be identified, though its magnitude may be measured. It is theoretically possible to underestimate as well as overestimate the depth of a defect. However, up to the present time no defect giving an ultrasonic indication less than from the five per cent notch has been found upon investigation to have depth greater than five per cent of wall thickness.

Discussion

Referring to visual and hydrostatic tests formerly used in inspection of high-pressure, high-temperature steam piping, one engineer observed that an internal crack might exist through a major portion of the wall thickness without being detected. The ultrasonic method equals in sensitivity any test now available, and interpretation of results is made practical by means of the five per cent notch. Another discusser reported using ultrasonic testing to detect ten defects in 300 pieces of ferritic alloy piping having an equivalent length of 700 ft, diameters of 6 to 10 in., and thicknesses of 0.432 to 1.125 in. All of these defects were found in pipe lengths which had passed mill inspection, and unless there had been chance observation of them during fabrication and erection, the piping would have gone into service with the flaws intact. Regarding manpower for ultrasonic testing, it was noted that a 30-ft section of pipe could be tested in one half man-hour.

Leak-proof Piping Joints

I. H. Carlson and **W. S. Black** of the Engineering and Research Division of the Crane Co. presented a paper entitled "Joints for High-Pressure, High-Temperature Piping" in which they outlined some of the problems of obtaining leak-proof joints. While welding is the answer in many cases, there are some instances, such as the joining of piping of different expansion characteristics and at points where piping must be disconnected from equipment, in which it is necessary to have mechanical joints.

Values of stresses resulting from differential expansion may be in excess of those permitted by code formulas dealing with pressure forces alone. For example, a temperature differential of 150 deg F between two points in a steel mass may produce a stress of 30,000 psi. Rapid changes in temperature offer the most troublesome kind of problem with pipe joints. Differences in temperature, in rigidity, in coefficients of expansion and in heat conductivity result in relative motion of sealing surfaces and permit joint leakage.

The joints under consideration permit relative motion between the two parts of the joint having differences in expansion due either to variation in operating temperatures or coefficients of expansion. The "pressure-seal" joint utilizes the fluid pressure acting against the full gasket circle area to obtain its sealing force between the conical surface of the stub end and the cylindrical surface of the socket flange. It is assisted by moderate initial bolt loading in the case of joints subjected to bending loads or operating on vacuum or low-pressure service. This type joint remains tight irrespective of the bolt elongation or adjustment because the conical seating surface maintains the same relative position to the cylindrical seating surface.

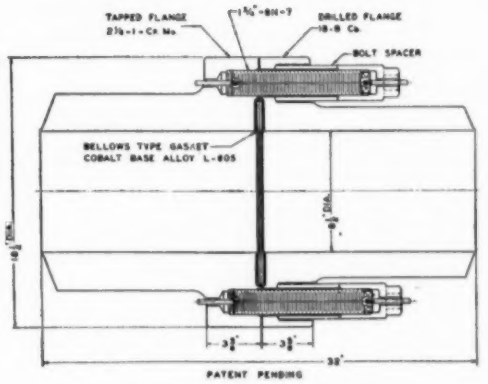

Fig. 2—Bellows-type gasket.

The "bellows" type gasket is intended to care for both axial and radial relative movements of the opposed flange faces. When the pipe is being heated, the inner rims of the faces are hotter and approach each other closer than the outer diameters of the same gasket chamber. When cooling, the opposite occurs, tending to open the joint. However, as long as the gasket seals against the flanges, pressure acting on the interior faces of the gasket tends to hold the gasket against the flanges in sealing engagement.

The "spiral-wound" gasket joint was made by remachining the bellows-type joint flanges to accommodate the spiral-wound metal, asbestos-filled gasket. In this assembly the flange faces are brought into contact over their entire width, thereby limiting the amount of gasket compression.

Laboratory tests, which were undertaken at the request of Sargent & Lundy and the Commonwealth Edison Co., were conducted to compare performance of the three types of joints by ascertaining the relative ability of the joints to remain tight when heated to

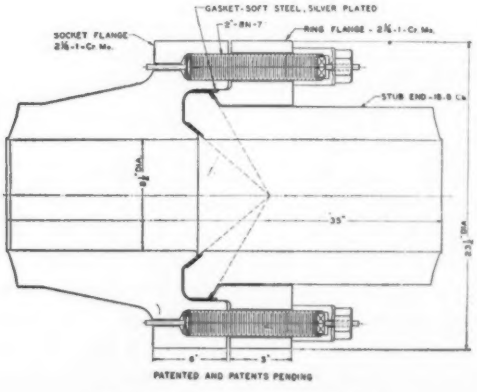

Fig. 1—Pressure-seal joint.

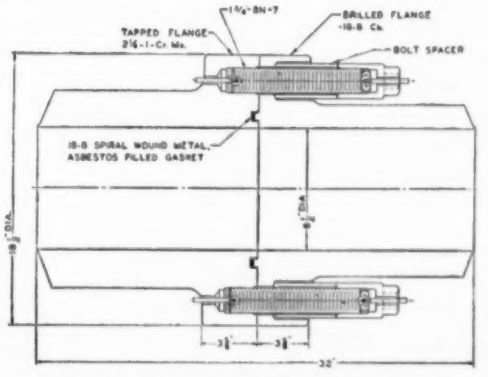

Fig. 3—Spiral-wound gasket joint.

1050 F and then cooled with saturated steam entering at 575 F. This was done 25 times on the pressure-seal, 23 times on the bellows-type, and twice on the spiral-wound gasket joint.

The test results, using three full-size joints for connecting ferritic alloy main steam piping to austenitic alloy turbine equipment, may be summarized as follows:

1. The special 10-in., 1900-lb pressure-seal flanged pipe joint remained tight throughout 25 cycles of heating to 1050 F and quenching with saturated steam at approximately 575 F.

2. The special 10-in., 1900-lb bellows-type flanged pipe joint leaked 11 times out of a total of 23 quench tests. The amount of leakage was extremely slight and the time of leakage varied from 15 seconds to 8 minutes. However, the joint sealed itself in every case.

3. Performance of the special 10-in., 1900-lb spiral-wound metal, asbestos-filled gasket flanged pipe joint in this application was unsatisfactory. During the first quench the spiral-wound gasket leaked moderately for 15 minutes after which the joint sealed itself. During the second quench the joint leaked severely.

Discussion

In the discussion of leak-proof pipe joints it was pointed out that some utilities now spend as much money in testing pipe joints as was expended for turbine-generator sets in the early days of the electric power industry. An interesting phenomenon associated with joint leakage is the occurrence of a refrigerating effect which may take place at the point of the leak and cool the metal in that region a greater amount than would ordinarily be expected. This effect apparently increases with the size of the leak.

German Power Plant Practice

From a background of experience as an engineering professor and technical manager of an electric power company, **L. F. Musil** of Graz, Austria, discussed the "Trend of Power Plant Practice in Germany." Noting that station rates in German central stations have continued to improve since World War II despite deterioration of the quality of available coal, he added that it has been possible to offset the high cost of burning inferior fuel by achieving economies in plant construction.

Average station heat rates over the thirty year period from 1915 to 1945 improved from 24,000 to 11,550 Btu per kwhr, using a natural supply of condenser cooling water, and to 11,700 Btu per kwhr in plants requiring artificial cooling.[1] This reduction in heat rates has been made in the face of burning lower grades of fuel, some of which have ash and moisture contents as high as 40 and 65 per cent, respectively.

Power plant sites are being selected, to an increasing extent, in close proximity to mines because of the relative costs of transporting inferior coal and transmitting electrical energy. Since adequate supplies of condenser cooling water are not generally available in mining areas, it is usual to employ artificial cooling. High ash content makes for a difficult technical and economic problem in disposing of ashes.

Optimum station capacities in the West German grid have been established at between 200,000 and 300,000 kw. Individual unit capacities are in proportion to station capacities and depend primarily on the reserve and load factors and secondarily on the price of fuel. By considering several stations in an area as a group, it has been possible to justify larger units, such as those of 100,000-kw in the brown-coal-burning plants at Frimmersdorf and Weisweiler. As for steam generating units, it is customary to install either one or two per turbine, depending upon the size of the turbine and the slagging characteristics of the fuel.

Selection of steam conditions is usually based on the relations of construction cost to the cost of heat units in the fuel. With rapidly rising fuel prices since World War II, even more attention is being paid to fuel saving than has been customary. The use of reheat results in a reduction in the sizes of pumps, circulating water system and feedwater heaters. The question then arises as to whether this saving compensates for the increased cost of reheat boilers and the added boiler-turbine piping.

In Germany the answer appears to favor reheat as long as the reheat temperature is not too high. A study made some years ago for the Elbe Power Station showed that by increasing pressure from 795 psig to 1580 psig construction cost would be increased 5.8 per cent; however, the use of reheat at the latter pressure was shown to reduce the additional construction cost to 3.7 per cent and to effect a net saving in fuel of about 3.5 per cent. Under existing German conditions the economies in the use of high steam pressures and reheat for large power plants with high load factors have been proved.

Cross-compound turbines have come into use because they improve the station reserve factor and are more easily controlled in high-pressure plants having variable loads. They result in lower construction costs for capacities in excess of 60,000 to 70,000 kw. These turbines also aid in the problem of plant regulation under variable loads by permitting the use of a separate speed governor on the condensing turbine and allowing, where desired, the insertion of a regulating steam accumulator between the two turbine sections. With increase in load the effect is first felt by the condensing-turbine governor, which causes a reduction in the intermediate steam pressure, to which both the govenor of the high-pressure turbine and the reducing valve at the steam outlet of the accumulator are responsive.

In general, fewer stages of feedwater heating are incorporated in German plants than in American plants. With pulverized coal firing and initial steam pressures in the 1000–1600 psig range, final feed temperatures of 350 to 370 F are usual, with four or, at the most, five stages of heating. Because of the low-grade coal, boiler availability is less than that of turbines, and interconnection of units is common practice. Up to the present only one station has been constructed without cross-connection, and in this instance two reheat boilers serve one 50,000-kw turbine.

The use of inferior coal has resulted in new attention being given to dust collection. While the electrostatic method predominated prior to World War II, mechanical collectors are now in widespread use. Two types

[1] Heat consumption reported here is based on low heating values of the coal as commonly used in Europe.

most highly regarded are the "vortex sieve" collector developed by Professor Feifel and the so-called "cellular collector" built by Rothemuehle. Tests of Feifel collectors showed efficiencies of 94 to 95 per cent, although a slightly higher draft loss is reported than for the electrostatic type.

The paper concluded with a discussion of the status of power plant standardization in Germany. As early as 1938 one of the boiler companies began to design standardized units in the capacity range from 40,000 to 250,000 lb per hr for pressures of 570, 1130, and 1770 psig. During World War II a standard 1770 psig boiler with a continuous rating of 290,000 and a maximum rating of 320,000 lb per hr was developed. Five central stations of 300,000-kw standard design were built during the War; the same structural designs were used for plants burning either brown or bituminous coal, and all purchasing, construction management, and labor control were handled by a central office.

Discussion

It was pointed out that comparison of German and American power plant practice may be misleading if one does not take into account the relative costs of labor and materials in the two countries. Since these differ markedly, it may be said that in many instances technical reasons for certain power plant practices are actually obscured by economic conditions peculiar to the country which practices them. This may be one reason why cross-compound turbines, which apparently are commonly used in Germany, have not been found economical in U. S. in sizes smaller than 125,000 kw.

Boiler Control

According to **J. F. Luhrs** of the Bailey Meter Company there are four trends in current boiler and power plant design which present interesting control problems for solution. These are (1) multiple fuel firing, (2) higher pressures and temperatures, (3) control of boiler water level by means of variable pump speed, and (4) centralized control rooms.

The fundamental problem in multiple fuel firing is to provide an energy input to the furnace sufficient to maintain steam pressure at the desired value and to maintain a fuel-air ratio that will provide optimum combustion efficiency. The problem of automatically proportioning fuel and air reduces itself to the measurement of Btu input to the furnace. With this known, air can be supplied in proportion to the input, regardless of whether one or more fuels are being burned singly or simultaneously. Three methods are available to determine and control the variation between Btu input and combustion air: (1) steam flow-air flow, (2) premeasurement, (3) gas analysis.

The steam flow-air flow method has been widely used for thirty years and remains one of the most desirable methods because it lends itself to the use of sturdy and reliable instruments. The development of commercially available mechanisms for totalizing the weight rate of flow of a gas or liquid fuel on a Btu basis makes possible the premeasurement of Btu input. However, up to the present there is no known method for accurately measuring the weight rate of flow of a solid fuel to a furnace. Gas analysis is one of the oldest methods of determining the ratio between the rate of Btu and air inputs, but in the present state of the art it is believed that gas analyzers have their greatest value in supplementing other methods of proportioning fuel and air.

Under ordinary conditions the greatest single factor causing relatively rapid changes in steam temperature is the flue gas flow over superheater elements. A measurement of this flow enables the anticipation of changes in steam temperature and the correction for such changes before there is a material change in steam temperature.

By varying boiler feed-pump speed to vary feed water flow instead of throttling pump discharge the following advantages are obtained: (1) power savings at partial loads, (2) longer pump life, (3) possible elimination of one valve in the boiler feed line, and (4) increased life of control valve in boiler feed line when such a valve is installed for low load operation or for emergency use. Variable speed may be obtained by means of a hydraulic coupling or similar device. In three-element feedwater control the pump speed is varied to maintain the rate of flow of feedwater equal to the rate of flow of steam, corrected in accordance with variations in drum water level. When there is sufficient range in pump speed, the feed control valve can be eliminated.

Discussion

A question was raised concerning the justification of multiple fuels in industrial plants having boilers of 30,000 to 100,000 lb per hr steam capacity. In reply it was pointed out that market conditions have determined the type of fuels to be burned and that flexibility of operation may be achieved with a relatively small investment in controls essential to burning several fuels, Because of the absence of heat-recovery equipment in many industrial plants of the size mentioned, the saving for central control, on a percentage basis, may be even greater than in central stations. Several engineers expressed regret that there is no instrument available to tell the instantaneous input in Btu for solid fuels. It was also mentioned that so-called central control might be more accurately characterized as remote manual control of operating equipment from a single point.

Tungsten Carbide in Coal Pulverizers

Experience in the application of tungsten carbide, as a protective facing for pulverizer elements to reduce wear, was reported in a paper by **W. C. Rogers** of Riley Stoker Corp.

In the type of mill with which wear-resistant materials were investigated, pulverization is by impact and attrition, the grinding elements consisting of stationary and moving pegs. With the exception of the hammer pegs, made of manganese steel, the milling parts were of hard nickel-chrome white iron which wore rapidly in service.

Hard facing grinding surfaces by welding with homogeneous hard materials had proved unsuccessful, and hard facing materials consisting of granules of tungsten carbide in a softer mix had failed by loss of the carbides from matrix erosion. Moreover, silicon carbide or

alundum grains bonded together and applied to form a protective facing failed by erosion of the bonding material. Boron carbide appeared promising but was rejected because of its brittleness and high cost.

The carbides of titanium, tantalum and tungsten were next considered. Of the three, tungsten carbide was available in both cast and sintered or cemented form. While early trials of the cast material demonstrated high resistance to abrasion, it was too costly and could not then be obtained in satisfactory shapes. The cemented carbides were also costly.

In subsequent post-war investigations only these two types of tungsten carbide were considered, since improvements in the fabrication of both had made available various shapes and sizes at reduced cost. Since the cast product was the harder, the initial studies were confined to it, and sample pieces were installed in a commercial mill, arranged to handle an abrasive silica sand. The condition of the carbide pegs after handling 180 tons was such as to indicate, at the prevailing cost of tungsten carbide, an eight to one reduction in maintenance expense compared with the standard alloy pegs.

Later service tests of the cast tungsten carbide with coal high in hard iron pyrites revealed some chipping of the facing; hence it was decided to try the cemented tungsten carbide under similar conditions. The results were most satisfactory. Compared to a previous average 10,000 tons without facing before renewal of parts, the cemented tungsten carbide facing showed no wear at 27,000 tons and at 50,000 tons all parts were still in excellent condition.

As a result the mill design has been altered to incorporate such protective facing of all parts exposed to wear.

Conversion from Coal to Oil

Stating that more than 80 per cent of the system capacity of the Boston Edison Company has been converted from coal to oil firing, **David H. Little** of that company described the oil storage, pumping and piping layouts employed at the Edgar, Mystic and L Street electric generating stations. These involve supplies of oil fuel direct from the refinery and by barge. At two of these stations the stokers were covered to permit oil firing.

The principal advantages listed for oil were savings in personnel and ash handling. Disadvantages mentioned were some difficulty from high sulfur content, necessitating more frequent washing of the air preheaters, and failure of superheater hangers from vanadium oxide in the oil. Also, because of the absence of slag on the furnace water walls, their heat absorption is greater and superheat thereby lower.

Discussion

One discusser cited the case of stack discharge from an oil-burning industrial plant where the dust containing vanadium had caused damage to the finish of automobiles parked nearby. Another stated that investigations had indicated the damage usually attributed to vanadium to be due to other salts in the oil, such as sulfur, but that vanadium acts as a catalyst.

It was mentioned further that the New England Gas & Electric Company is also converting both its power and its gas plants to oil.

However, the opinion was expressed that the widespread conversion to oil firing in New England is likely to result in a rise in oil prices and a consequent reversion to coal in many instances, although the scarcity of good gas coals points to the permanent use of oil for gas making.

Standardized Boiler Units

Defining a standardized boiler as one that has been completely designed in reasonable size increments to take care of various space conditions, different fuels and methods of firing, **Carl E. Miller** of Combustion Engineering-Superheater, Inc., pointed out that most such designs are for capacities under 60,000 lb of steam per hour and pressures up to 400 psi. Although usually built to supply saturated steam, standard superheaters can be incorporated in many to supply nominal superheat. Oil or gas firing may be used for all sizes; the single-retort underfeed stokers are common for capacities below 30,000 lb of steam per hour; and above this either the spreader or traveling grate type of stoker is usual. Pulverized coal is seldom employed in such sizes. Some of the smaller units are shipped completely assembled with all auxiliaries applied.

Above 60,000 lb per hr standardized units are available to the extent that certain parts are completely standardized, although other parts are individually designed.

Mr. Miller then proceeded to discuss some of the basic design principles of standardized boilers with particular reference to supports, furnace, convection surface, circulation and casing. He also discussed at some length the merits and limitations of the various methods of firing.

Illustrations and descriptive matter covered a compact oil- or gas-fired forced-circulation unit for capacities up to 6000 lb per hr; a typical standardized firetube boiler; a two-drum standard unit for moderate capacities and capable of burning any type of fuel; and a two-drum boiler suitable for larger capacities and all types of firing. He summarized advantages of such units as follows:

They have permitted raising the performance of small plants; they are built as one coordinated unit including all auxiliaries and combustion control, and employ correctly designed and properly proportioned fuel-burning equipment; they involve a reduction in engineering costs; they permit speeding up of fabrication and delivery; and make it possible for the purchaser to obtain early information on foundation and piping requirements.

Discussion

Attention was called to the particular adaptability of such standardized units to semi-outdoor plants, because they do not have to be fitted into steelwork that may be restricted by other considerations; also, that it is especially desirable that provision be made for the future use of low-grade coal on the Eastern Seaboard where the residual blended oils now coming in are running relatively high in sulfur, in some cases up to 7 per cent.

Gas Turbine Charts

"Convenient Gas Properties and Charts for Gas Turbine Calculations" was the title of a paper by **C. J. Walker** of General Electric Company. This presented a method of plotting data on gas properties for everyday use with sufficient accuracy for engineering calculations, including test performance of gas turbines.

For available energy or isentropic work, linear interpolation charts with logarithmic energy scale give the ratio of energy to initial temperature as a function of pressure ratio for a perfect gas, as $n = 1.4$ and $R = 53.3$, where n is the specific heat ratio and R the gas constant. For actual gases the correction to the charts is a function of pressure ratio and initial temperatures only. Such factors are given in chart form for a number of gases and gas mixtures, for both compression and expansion.

Enthalpy for various gases and mixtures is plotted as h/T (ratio of enthalpy to temperature), and a convenient method of plotting combustion temperature rise, as a function of fuel-air ratio and either initial or final temperature is presented. Various flow factors, reheat factors, and energy factors, as functions of specific heat ratio and gas constants are also included for convenience in making turbine calculations.

Flow of Flashing Mixtures

A simple method of designing piping and valves, particularly heater drain piping, to carry a flashing mixture of water and steam was presented by **W. F. Allen, Jr.**, of Stone & Webster Engineering Corp. in a paper entitled "Flow of a Flashing Mixture of Water and Steam Through Pipes and Valves." In sizing piping such as cascade drain lines between feedwater heaters, experience has shown that the usual criteria for liquid flow are unsatisfactory and that the use of empirical formulas or arbitrary selection offers no guarantee of the adequacy of the capacity of the piping system.

In analyzing the two-phase mixture of water and steam it is assumed that they flow as a finely divided mixture with equal average velocities. The analysis indicates that a critical pressure will exist at the throat of throttling restrictions and, under certain conditions, at the end of pipes conveying initially saturated liquid. The effect of friction in creating an unequal velocity distribution over a cross-section will be more pronounced with small diameter pipes than those of larger diameter; and the absence of bends in the piping will tend to perpetuate the unequal velocity distribution. The less finely the liquid is divided in the vapor, the more probable it is that the average water velocity is less than the average steam velocity. It may be shown that the effect of this condition is to increase the maximum rate of flow over that for equal velocities and to decrease the critical pressure from the value found with equal velocities.

The most economical piping arrangement is one that will pass the flow over the entire load range without operating difficulties and be free from injurious effects of erosion or vibration resulting from high water-steam mixture velocities. While the inclusion or omission of a drain cooler is dictated by the economies of the overall plant, its use in the drain system serves to restrict the amount of flashing and makes possible the use of smaller valves and piping. By utilizing critical pressure phenomena and sizing the pipe from the control valve to the receiver so small that the pipe exit critical pressure is above the saturation pressure corresponding to the exit temperature from the drain cooler, it is possible to eliminate flashing. To do this there must be sufficient pressure differential available to overcome friction in the piping and the differential across the control valve. In sizing the pipe such variables as initial pressure, rate of flow and pipe friction are involved, and it may therefore be impossible to carry out the design so that flashing is eliminated over the entire load range. In this case, the design calls for piping large enough to pass the flow at high load without flashing and allows flashing at very low loads.

Fourth Power Session

The fourth Power Session, on Wednesday afternoon, contained two papers, both of which had previously been presented at the Midwest Power Conference in Chicago last April and appear in full in the published 1950 Proceedings of that Conference.

The first of these was entitled "Steam Lift in Hot-Process Water Softeners," by **A. A. Kalinske** and **J. M. Kahn** of Infilco Inc. Briefly, this described how, in order to obtain the advantages of rapid mixing, flocculation and conditioning of the precipitates formed in the hot-process, solids contacting of the raw water and chemicals with previously formed precipitates was incorporated in a hot-process softener, simulating the cold-process "Accelator." This is accomplished through circulating slurry by means of steam-lift principles. Use of a steam lift for pumping the slurry and circulating it results in deaerating the raw water; hence elimination of a raw-water deaerator is made possible.

Design criteria for such a steam-lift deaerating hot-process softener were established from pilot plant studies, and operation of a full-scale installation under practical operating conditions has provided confirmation.

The second of these papers under title "Investigation of Steam Separation in Boiler Drums Through Studies on a Model " was presented by **Erich A. Farber** of the University of Wisconsin. Its purpose was to find and compare the best design of drum internals to obtain the least carryover and minimum entrainment. A method to accomplish this was developed and described.

Citizenship Responsibility

At the President's Luncheon James D. Cunningham, President of the A.S.M.E., urged the formation of small, informal discussion groups of engineers to take an active interest in citizenship responsibility in this time of international crisis. Noting that there are many who feel confused and apprehensive, Mr. Cunningham asked whether we have not placed too much emphasis upon our technical efforts at the expense of human problems. Although the United States has reached the pinnacle of technical power in a mechanized civilization, the facts are that

happiness does not seem in prospect and that the future, in many respects, appears dark with bewilderment, doubt and possibilities of catastrophe. The failure of engineers to recognize and respond to broad responsibilities as citizens and their lack of understanding that technical knowledge is not enough may be the key to many of the greatest difficulties facing America today. Attention must be turned from technical problems to insure the survival of economic society as it is now known. The greatest hope for the future, however, lies in an awakening interest in spiritual and moral as well as technical values. Engineers who have failed to accept a minimum of civic responsibility in the future must be keener as citizens and as human beings.

M.I.T. Head Views the Draft

The drafting of all men of draft age if the present emergency worsens, and then assigning them to civilian as well as military duties, was advocated in an address at the banquet on Wednesday evening by **Dr. J. R. Killian, Jr.**, president of the Massachusetts Institute of Technology. The problem would then become, not one of deferment, but of where a man can best serve his country. He urged, however, that regardless of a general war, a certain number of young men, competent to benefit from college, should be required to continue their education in essential fields. He added that the recently announced selective service policy of deferring students above a certain standing in their classes after the freshman year is perhaps the best compromise now possible.

"It is easy for panicky people and short-ranged minds to class education as a non-essential activity, because in curtailing it no unfortunate effects could be immediately perceived," declared by Dr. Killian. "If you stop farming, people starve, or if you shut down the railroads, the nation's economy grinds to a halt; but if you stop education, people merely remain ignorant and not uncomfortable, and the disastrous effects of the ignorance do not become clear for years. If we prematurely disrupt or seriously curtail our higher education, we could in the end wind up with a disastrous shortage of trained manpower."

The M.I.T. president condemned piecemeal proposals to draft scientists in the same manner as doctors, declaring that this would work to the disadvantage of our military research and long-range potential, and expressed the opinion that establishment of an organization comparable to the National Defense Research Committee and the Office of Scientific Research and Development, which so effectively mobilized science in the last war, would be premature at this time.

In line with the views expressed from time to time by some other educators, Dr. Killian blasted the special oaths and legislation aimed at communism and urged instead an espousal of the concepts of democracy and freedom. He said the four common denominators in the outlook of Americans were a deep-seated faith in the future; a willingness to accept change, which he termed a readiness to modify our understanding of the right way whenever it is found to be in error in respect to the general welfare; a tolerance of differences, which he said was a repugnance for regimentation and an acceptance of dissent; and lastly, a spiritual unity of the people which overrides our religious diversity.

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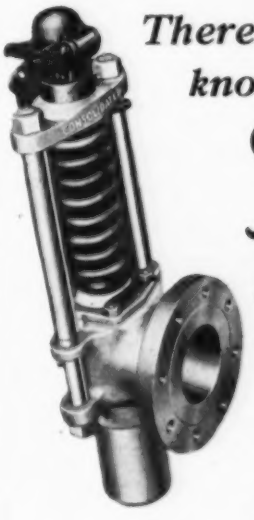

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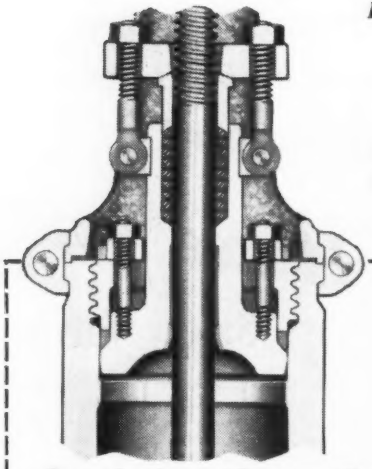

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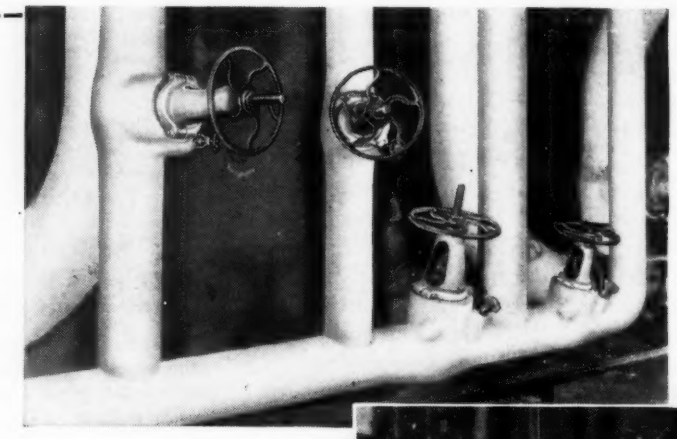
The bonnet joint as shown above is inside the valve, and the sealing element is a wedge-shaped seal ring. Internal fluid pressure, acting upon the entire underside of the bonnet, forces the bonnet against the seal ring; this wedges the metal seal ring between the body and bonnet, forming a pressure-tight metal-to-metal joint.



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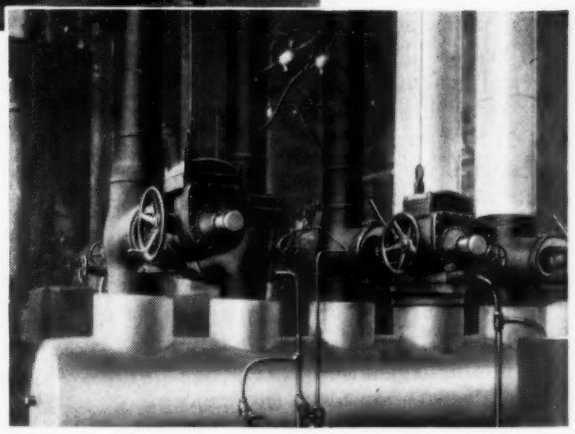

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Experience With High-Pressure, High-Temperature Steam Central Stations

In these excerpts from a paper delivered at the recent World Power Conference in London, the author reviews operating experience of central stations in the United States, showing high pressures up to 2300 psi and high temperatures up to 1050 F, to be entirely satisfactory. Turbine and boiler availability and outage causes are discussed, as well as metallurgy, feedwater treatment and trends.

By P. W. THOMPSON

Vice President in Charge of Engineering,

The Detroit Edison Company

USE of larger capacity units in modern plants, reduced duplication of associated facilities owing to increased reliability and general simplification of plant structures have tended to lower the cost of plant. However, higher steam pressures and temperatures require more complex steam generators, turbines and auxiliaries, as well as heavier piping and valves, and these may result in a net increase in the cost per kilowatt of installed capacity of plants employing such steam conditions.

Justification of higher steam pressures and temperatures, therefore, lies in the effect of the fuel savings upon the overall economy of the plant, including fixed charges. Principal items affecting the situation in each case are the cost of fuel, plant use factor and fixed charges on the investment.

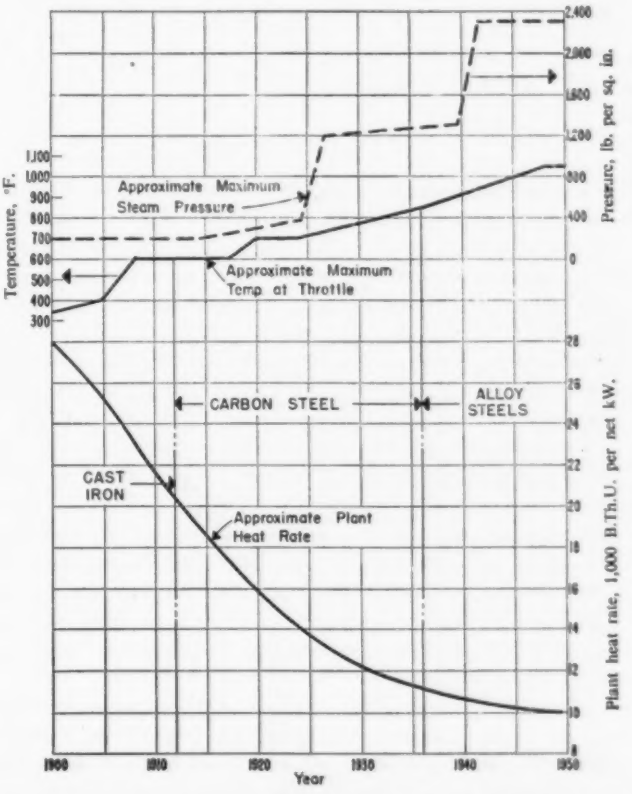
The progressive increase in maximum steam pressures and temperatures of plants built in the United States, beginning with 1900, and the corresponding plant heat rates are shown in the accompanying chart.

A forerunner of the general acceptance in the United States of temperatures above 750 F was the successful six-year operation in this country, starting in 1930, of a 10,000-kw turbine-generator unit at 1000 F. At the same time a test superheater was operated at 1100 F. Operation of these units demonstrated the feasibility of such steam conditions for power plant use.

Plant Performance

Operation of plants and equipment at elevated steam conditions requires a somewhat higher degree of operating skill than is necessary with lower steam conditions. Many companies, therefore, conduct extensive operator training programs to develop competent personnel.

Operating experience with high-pressure, high-temperature plants and equipment has been satisfactory and not significantly different from that with earlier installations employing lower steam conditions. Modern American plants have shown an average annual availability of better than 90 per cent excluding periods of low demand during week ends and holidays. Availability expressed on this basis is somewhat different from that in which total time is used as a reference, but it is believed to be a better measure of dependability since it relates specifically to the periods when the equipment is, or might be, needed to meet load demands. Long-range scheduling of maintenance outages, careful planning of inspection procedure and the use of multiple shifts in succession to lengthen the working time during maintenance periods have shortened equipment outage time by about one-third during the past four years.



Changes in Steam Conditions and Plant Economy

The starting and stopping of turbines in modern stations require closer supervision than for units in older plants because of the higher temperature differences involved. However, elevated steam conditions have not handicapped the operation of such stations, nor have load variations resulted in problems, even in those plants with low-load factors or where such stations are used to supplement hydro generation.

Experience of those plants employing the reheat cycle has been generally satisfactory. Operation of reheat equipment with extremely high pressures has been limited to two plants, one of which employs a natural circulation steam generator at 2400 psi, while the other uses a forced-circulation boiler of the Lamont type at 2000 psi. In the older reheat installations, operation is somewhat more complicated than with the straight-through regenerative cycle, but in the newer installations the arrangement of the reheating surface in the steam generator is such that cooling of this section during starting or sudden loss of load is not necessary. Operation is thus considerably simplified.

Experience is being gained in many new plants and plant extensions with the so-called centralized control room. In this arrangement, operating gages and control devices for all essential operating equipment, including electrical apparatus, are located at one central point in the plant. From this location, the entire plant operation may be supervised by a smaller group of operators than is otherwise required. Reliability of operation with this scheme has been good, and reduction in operating cost has been effected.

In coal-burning stations, the handling of fuel continues to present problems such as the dust nuisance in metropolitan areas, the stoppage of flow in chutes when coal is wet and the handling of frozen coal at those plants where severe winter weather in encountered. Likewise, stack emission of dust continues to be a problem necessitating large investment in dust-collecting and handling equipment. This problem is aggravated by the high ratings at which modern plants are operated.

Turbine-Generators

The annual availability of turbine-generators excluding periods of low demand during week ends and holidays, averages 94 per cent. The steam turbine accounts for two-thirds of the outage, while the generator, auxiliaries, and other related equipment account for the remaining one-third. Considerable work, such as adjustments, cleaning and minor repair, is done during week-end shutdowns and thus does not subtract from the availability of the equipment during high-demand periods.

Experience with modern turbine-generators has led some companies to extend operating periods to 40,000 or 50,000 hr between overhauls. Other companies have adopted the practice of opening turbines only when stage pressures or performance indicate the necessity. An average outage period of 24 days is required for a complete inspection and overhaul of a turbine-generator. Such units are, on an average, completely inspected every three years.

In general, causes for outage of high-pressure, high-temperature turbine-generators have been no different from those for units operating at lower steam conditions. The trouble responsible for the greatest loss of service is failure of buckets and blades in the moisture region. Such failures are either of a fatigue or a corrosion-fatigue nature. Remedial measures consist in the use of heavier blade sections and, in some instances, changes in shrouding or lashing wire design.

In certain installations, leakage at joints of high-pressure turbines of single-casing design has been an aggravating source of maintenance, requiring seal-welding of the joints. Leakage has not been encountered in double-casing designs for 1250 psi and above.

Bolting material has been generally satisfactory, but failures have occurred in turbine-casing and valve-bonnet bolts in installations operating at temperatures from 825 to 950 F. These failures have resulted from embrittlement, as indicated by a marked loss in impact strength of the material. Some operating companies have adopted programs for reheat treatment of bolts at regular intervals to restore ductility and to prevent failures that might occur due to gradual embrittlement during long service. More recently, failure of headed austenitic bolts used to secure the nozzle block to the casing of a 1050 F turbine has been reported. Low ductility of the material and high bending stresses underneath the head, due to misalignment, were indicated as the probable cause of the failure. Proper alignment and heat treatment of the new bolts are expected to correct the situation.

Cracking on the interior surfaces of high-pressure cylinder casings and steam chests has occurred but has not been of a serious nature. Repairs have been made by removal of the metal in the cracked area and building up by welding, or in some cases further progress of the crack has been arrested by simply drilling at the tip of the crack to relieve concentrated stresses.

Water erosion of low-pressure blades, buckets and casings is a problem. The use of stellite strips on the back of the last-stage buckets has prolonged their life. Where interstage leakage has occurred as a result of water cutting, the installation of copper or stainless steel inlays at the casing-diaphragm joints has stopped the leakage and prevented further damage. Such inlays are now being incorporated in new designs.

Loss in turbine capacity due to the accumulation of both soluble and insoluble chemical deposits in turbine steam-flow passages continues to be a problem in some plants.

In turbines subject to frequent starting and stopping, water-soluble deposits, in most instances, are automatically removed during this process. In other instances where deposits are not thus automatically removed, water and saturated steam are introduced into the turbine while turning at low speed. Such washing is done as frequently as every four to six weeks, or it may be extended to intervals of a year or more, depending upon the rate of accumulation. Where water-insoluble deposits are encountered, caustic washing or fly-ash blasting is employed. The basic cause of such deposits is silica. Its ingress into the system is principally through the condenser as raw-water leakage and through the evaporator as carryover.

Steam Generators

The average annual availability of high-pressure, high-temperature steam generators is somewhat lower than the 94 per cent reported for turbine-generators. An important fact influencing this availability factor is that in

nearly all cases, governmental agencies and casualty insurance companies require a complete yearly inspection of steam-generating equipment, whereas turbine inspections average once every three years.

The major cause of emergency outage of steam generators is failure of pressure parts, particularly tubes. Cleaning of external heat-exchange surfaces, replacement of worn combustion equipment and repair of fans and other auxiliaries account for the remaining outage time other than scheduled annual overhaul.

Slagging of superheater and economizer tube banks continues to be an operating problem in coal-burning plants. Remedial measures are being studied by several of the operating companies. Washing of slag-covered tubes with hot alkaline solutions, followed by an application of a lime slurry, has been offered as a means of retarding slag formation. Slagging in boilers using fuel oil containing traces of vanadium also presents a serious operating problem. A very hard, tenacious slag is built up that is extremely difficult to remove. Hot-water washing of surfaces with the unit out of service appears to be the best solution at present.

Developments of retractable soot blowers have contributed to longer service periods by making possible the cleaning of hot sections not accessible to fixed blowers or hand lances. Use of air at 200–300 psi for soot blowers has likewise contributed to cleaner boiler surfaces by the elimination of moisture.

As a result of close supervision of feedwater conditions in high-pressure, high-temperature plants, comparatively little trouble has been experienced with scale and corrosion in boiler tubes.

Auxiliaries

Although not a new phenomenon, the so-called corrosion-erosion attack on centrifugal boiler-feed pumps, feedwater regulating valves and associated piping has presented an exceedingly troublesome maintenance problem. In some cases the resulting metal wastage in centrifugal pumps has reduced efficiency and capacity to a point where replacement has been required.

As this trouble grew in magnitude, a special test procedure was developed to enable selection of materials for boiler-feed pumps that would withstand corrosion-erosion attack better than the carbon steel, bronzes and other materials then in use. It was found that chromium-bearing steels possessed excellent resistance to attack. Several years' service experience has shown that, for most feedwater conditions, a 5 per cent chromium material is satisfactory. With highly corrosive feedwater or unusually high water temperature, tests indicate that a 12 per cent chromium steel is required, and that for the most severe conditions, 18 per cent chromium-8 per cent nickel steel is necessary to withstand attack.

Experience with the head joints on closed extraction feedwater heaters has been varied. Some heaters installed on the discharge side of the boiler feedwater pumps have given trouble, requiring seal-welding of the joints or the removal of insulation from the bolts to maintain tightness. Those heaters initially equipped with steel tubes—a wartime measure—have nearly all been refitted with nonferrous tubes. The steel tubes have corroded, resulting in reduced heat transfer and failures.

Many companies have encountered the problem of keeping induced-draft fans in service because of ash erosion. High ash content of fuel, together with high sustained boiler ratings, has added to this problem.

Metallurgy

GRAPHITIZATION—The failure in 1943 at a welded joint in a high-pressure, high-temperature steam pipe without warning or suspicion of weakness was cause for extreme concern among operating companies. Steam conditions were 1300 psi, 935 F, and the steam line had been in service for approximately $5^1/_2$ years. The failure occurred adjacent to a weld which connected the main steam line to the superheater outlet header. Investigation showed that the failure was due to graphitization of the steel; that is, the carbide structure had broken down to yield free carbon or graphite, which formed a weak or brittle plane through the pipe adjacent to the weld.

Since this occurrence many examinations have been made of the welded joints in high-temperature steam power plants. Examinations have shown graphitization in medium-carbon steel at 800 to 875 F and in carbon-0.5 per cent molybdenum steel at 900 to 975 F. In general, where it has occurred, it has been evident within approximately 40,000–50,000 hr of operating service, although it may occur after longer periods of operation.

The results of investigation of the problem are that (1) high-aluminum deoxidized steel is more prone to graphitization than low-aluminum deoxidized steel, and (2) the addition of about 1 per cent of chromium to steel effectively prevents graphitization.

Several companies have replaced graphitized pipe with chromium-molybdenum pipe, and a number of companies have undertaken programs of rewelding the joints. Rehabilitation of graphitized joints by heat treatment, *in situ*, has also been done. To prevent graphitization at welded joints in new steam piping installations, it is the general practice now to limit the use of carbon steel to 775 F and carbon-0.5 per cent molybdenum steel to 875 F. For temperatures up to 975 F,-1.0 per cent chromium-0.5 per cent molybdenum steel is being used. For temperatures of 1000 and 1050 F it has been and continues to be the practice to use alloy steels containing 2–3 per cent or more of chromium which are not subject to graphitization.

Water Treatment

Makeup water for high-pressure, high-temperature steam generators is generally produced in evaporators. In many stations, raw undeaerated water is fed directly to the evaporators. If chemical treatment of the water before it enters the evaporators is adopted, selection between chemical softening and ion-exchange processes is dependent principally upon the character of the raw water. The development of ion-exchange resins has reached a point where ion-exchange systems of the demineralizing type are used in some plants instead of evaporators. Such systems are reported capable of removing all salts from the raw water, including silica, and thus eliminating the problems that develop as the result of carryover from evaporators.

Carryover from evaporators contributes to the most serious problem arising from water that is encountered in modern power plants—that of silica contamination of

steam and its resultant deposition as an adherent, insoluble scale on turbine blades and in superheater tubes. Raw-water leakage of the condensers is another important source of silica that is frequently found in boiler feedwater.

To combat condenser leakage, current practice is to roll the tubes at both ends. Evaporator carryover generally presents a more difficult problem, and the rather general inability to secure uncontaminated steam from evaporators suggests the possibility that rated capacities are too high.

Minor Water Problems

Besides these problems arising through the presence of silica in the boiler water, there are others that may be considered minor in that they are encountered in isolated instances. These include the "hiding-out" of phosphate salts stemming from the water-treating chemicals, the formation of black magnetic oxide resulting from steam blanketing and subsequent overheating of the tube metal, the presence of copper and copper-oxide scale attributed to ammonia and carbon dioxide in condenser leakage or evaporator products and corrosion believed to develop through the inadvertent ingress of air or undeaerated water.

There have been no reported cases of caustic embrittlement in high-pressure, high-temperature steam generators. In order to combat any tendency toward its development, and at the same time to provide adequate scale and corrosion-preventive treatment, the maintenance of a proper relationship between pH and the concentration of the phosphate ion so as to preclude the formation of free OH-ion is practiced by some companies.

Trends

Practically all new capacity being installed in this country, or on order for new installations, has rated steam conditions above 800 psi and 800 F. The highest steam temperature specified is 1050 F at pressures from 1500 to 2000 psi. An increasing portion of the new capacity being added each year is designed for steam conditions closely approaching these upper limits.

It is expected that steam temperatures will exceed the present limit when suitable materials become economically practicable. The wartime development of "super" alloys for military purposes has accelerated metallurgical developments of materials for higher-temperature steam service.

There is a marked trend in new plant designs toward the reheat cycle to achieve further gains in thermal economy within the present temperature range, particularly for large-size units with anticipated high-use factors.

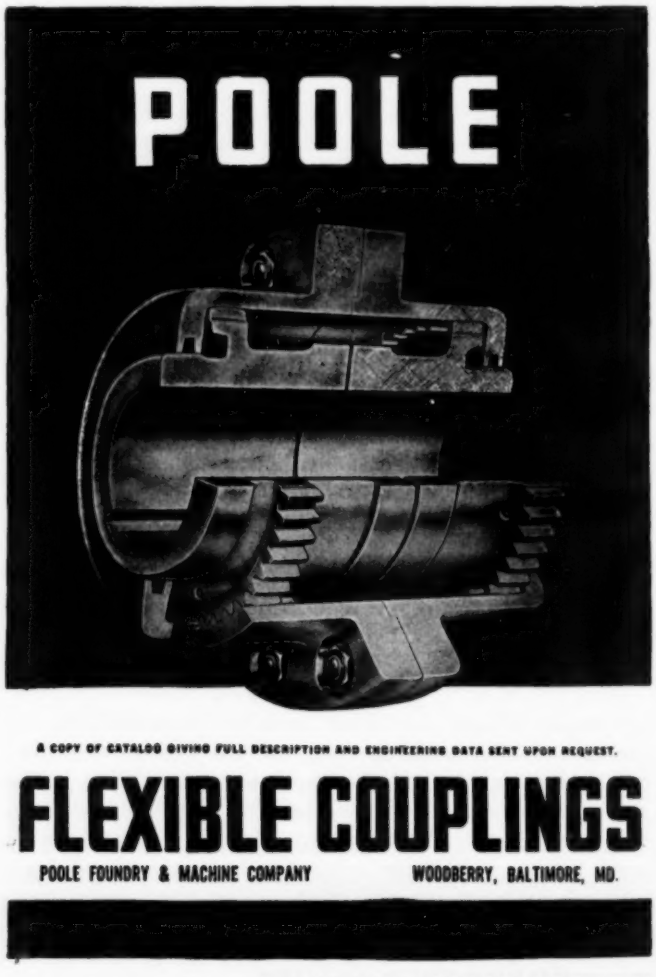
The unit boiler-turbine arrangement contributes to operating simplicity and lower plant cost and, therefore, has found increasing favor among utilities. Higher availability of boilers and turbines has been an important factor in the acceptance of this scheme. Unit boiler-turbine designs are well suited for the incorporation of reheat.

Having reached the point where scheduled capacity additions promise to overtake anticipated load growth and re-establish normal reserve margins, there is some renewed interest in superposed units for topping older plants to increase their thermal efficiencies.

To offset increasing costs of power plants there has been, and continues to be, a trend toward so-called outdoor and semi-outdoor stations in regions enjoying milder climates. In these designs the elimination of varying portions of the building structures tends to reduce the cost per kilowatt of station capacity.

The large increases in loads on individual electric power systems, together with the more extensive interconnection of regional systems, have resulted in a trend toward generating units of larger capacity. Nearly all new units up to about 100,000 kw capacity are of the 3600 rpm design. Larger units are either of 1800 rpm design or of the cross-compound type in which the high-pressure element turns at 3600 rpm and the low-pressure element at 1800 rpm.

Further increases in thermal efficiency in future steam power plants are looked for through the use of higher pressures and temperatures. Further reduction in operating personnel through the use of centralized controls is expected to contribute to holding production costs to a minimum. Standardization of equipment designs, where possible, together with advances in the art of plant design and construction, are relied on to help combat tendencies that are apparent toward further increases in the first cost of new stations.



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

Pump Assembly Simplified By Spiral-Wound Gaskets

AN interesting solution to a sealing problem in multi-stage boiler feed pumps of the cylindrical double-case type was effected not long ago. These pumps, of Ingersoll-Rand design, which normally operate at 3550 rpm, are made up of segments, each stage being a separate segment. Sealing is required between stages and at the main discharge joint. It had previously been the practice to provide an auxiliary seal in addition to the ground metal-to-metal fits between segments. To accomplish this auxiliary seal dead soft copper gaskets were used at each joint assembly.

Assembly of the segmental components of the pump was a tedious job, demanding many time-consuming compression checks. It was a precision operation, requiring extensive use of micrometers and feeler gages to make certain that correct predetermined compression was obtained accurately all the way around at each segmental joint—stage by stage.

Later, when it became necessary to overhaul a pump in the field, the same problem arose. When the pump was ready for reassembly, maintenance men again had to spend a great deal of time in checking for proper compression.

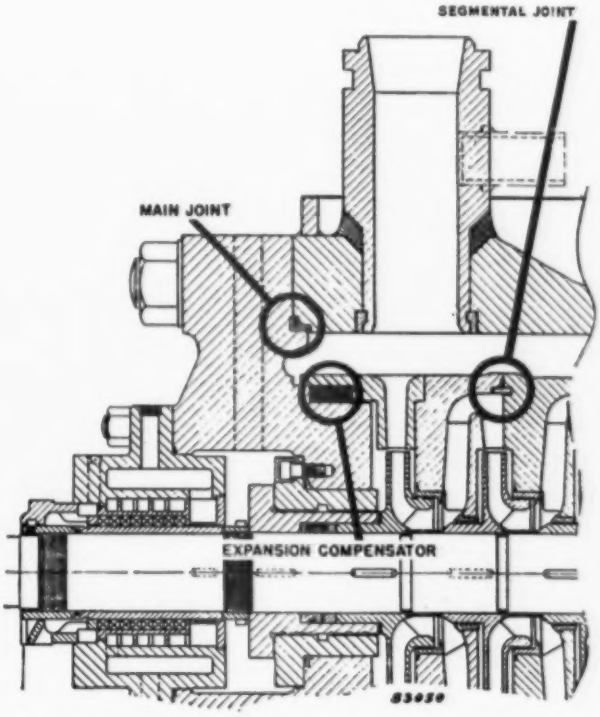
Therefore, with a view toward simplifying or eliminating the checking of stage-to-stage sealing, the pump manufacturer approached the Flexitallic Gasket Co. whose engineers showed how the spiral winding of V-shaped, interlocking metal plies, alternating with plies of filler, could be adapted to the segmental joint assembly, and that such gaskets could be made as hard or soft as the application required. Moreover, several types of metals and fillers could be used in combination, depending upon joint requirements, pressures and temperatures. For this particular segmental joint use, a spiral-wound gasket of stainless steel and asbestos filler of 0.175 in. thickness was necessary.

Experimental Pump

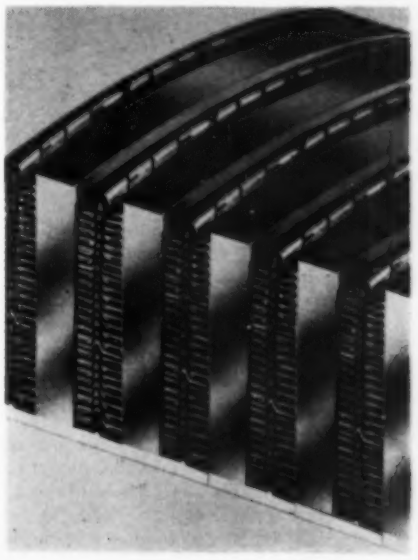
Accordingly, an experimental pump was built in which the interstage joint was designed with controlled gasket compression and metal-to-metal contact between stages, thereby eliminating time-consuming compression measurements.

Not only was interstage contact found easy to establish, along with a tight seal, but the resilience of the spiral-wound gasket also assisted in the disassembly operations. When the bolt tension was removed, the resilient gasket structure actually aided in separating the joints.

Further experiments showed that the inherent resilience of the gasket could be used in the expansion compensator. Prior to this time the expansion compensator had been a complicated and expensive unit, in some designs, dished steel disks or sleeve-type slip joints having been used. However, in the present pump, the expansion compensator, located between the last channel ring and the discharge head incorporates a series of spiral-wound gaskets separated by stainless steel spacers.



Sketch showing locations of main joint and expansion compensator



Cutaway view of spiral-wound gaskets and stainless-steel spacers

This construction serves a dual purpose. First, as the discharge head is bolted up, the compressive force produced is transmitted through the expansion compensator to the inner assembly, compressing the inner stage seals and allowing metal-to-metal contact. When this has been obtained at the discharge head, the compensator is compressed approximately 50 per cent, the remaining half of its compressive capacity being available to fulfill its second purpose, namely, that of absorbing any expansion or contraction between the inner assembly and the shell. The yield value of the expansion compensator gaskets is greater than the inner stage-to-stage seals.

The entire interlocking segmental assembly is inserted into the case as a "bundle," held together by tie-rods, their only purpose being to simplify handling. In addition to the rotating parts, the segmental type inner casings which form the "bundle" consist of the suction ring and the required number of channel rings. Within the inner casings are the hydraulic passages, impeller chambers, and diffusors. Final bolting secures the entire inner assembly and heavy outer casing.

New York City's Smoke Ordinance Now in Effect

THE new regulations for smoke control in New York City became effective on October first and are under the administration of the Bureau of Smoke Control, of which William G. Christy is the director. There is also a Smoke Control Board, consisting of the three members of the Bureau plus the Commissioners of Health and of Buildings and Housing. One of the functions of this Board is to consider appeals. The rules adopted prescribe the requirements for fuel and refuse burning equipment, specify limits to the emission of air contaminants, and govern the issuance of permits and certificates for installation of equipment. They are set up as the minimum requirements to be observed by architects, engineers, contractors, equipment manufacturers and plant or building owners. There are certain exceptions applying to small commercial equipment for space heating and hot water, and to minor alterations. The following digest covers some of the more important points of the ordinance:

Smoke

Dense smoke, defined as that which cannot be seen through at the point of emission, shall not be emitted into the open air from any fuel-burning equipment, internal-combustion engine, locomotive, marine craft, etc., except for a maximum of four minutes when a fire box is being cleaned or a new fire is being built in a cold boiler. Smoke other than dense is not permitted in excess of two continuous minutes in any one hour.

As to incinerators, while dense smoke from them is not permissible at any time, smoke other than dense may be emitted for a period not exceeding two continuous minutes in any one hour, providing objectionable odors are not involved.

Dust

Gas emitted from power plant stacks shall be limited to the following dust contaminations:

Steam Generated, Lb per hr (Average)	Pounds of Dust per 1000 Lb Steam
100,000 or less	2.2
150,000	1.9
200,000	1.7
300,000	1.4
400,000	1.2
500,000	1.0
600,000	1.0
800,000	0.9
1,000,000 or more	0.8

The above figures may be exceeded during cleaning periods, providing the methods used and the period of time are approved by the Director of Smoke Control.

For other than steam generation, dust in discharged gases is not to exceed 0.85 lb per 1000 lb of gas, of which amount not more than 0.40 lb per 1000 lb of gas shall be of such size as to be retained on a 325-mesh U. S. standard sieve.

The amount of solids in the gases is to be determined according to the A.S.M.E. test code for dust separating apparatus, or by other methods approved by the Director.

Ocean-going vessels shall not operate soot blowers while within the waters under New York City jurisdiction.

Excess Emission

When any emission in violation of these rules is found, the Director shall order the offender to abate it. There is a further provision that if the offender proceeds immediately to undertake corrective measures, the Director may stay the effective date of the order by not more than 60 days.

Sealing of Equipment

When an owner or operator of any equipment has been previously notified of three or more violations within any consecutive twelve-month period, he will be called upon to show cause why the offending equipment should not be sealed.

Permits

No person will be permitted to construct, reconstruct, install or alter any equipment capable of emitting smoke, fly ash, etc., until an application, accompanied by plans and specifications, has been filed and a permit issued; nor shall any such work be done that does not conform to the plans and specifications so filed. Each application shall include a statement certified by a licensed professional engineer as to size, capacity and load of the equipment to be used. Exceptions include minor alterations; repairs to previously approved equipment; internal combustion engines, marine installations and portable equipment; and to fuel-burning equipment and space heaters when standard commercial equipment is used and the maximum fuel input does not exceed 350,000 Btu per hr.

Operating Certificate

New, remodelled or reconstructed fuel-burning equipment for the production of heat and/or power shall not be used without an operating certificate issued by the Bureau, with the exceptions as noted above.

Tests

The Director may, at his discretion, require a test of a new or altered installation, such test to be made at the expense of the person receiving the certificate or approval. Moreover, the Director may require the submission of an analysis of the stack discharge. This analysis must include the type and quantity of gases being discharged, as well as the quality and character of the solid matter. These tests must be made by, or conducted under, the supervision of a licensed professional engineer, and at the owner's expense.

Fees

A separate permit and a separate certificate shall be required for each unit of fuel-burning equipment. In the case of a boiler, furnace or water heater with integral gas or oil burner, or stoker, only one permit and one certificate will be required for the combined unit; although air or steam jets require separate permits for each boiler or furnace. No fees are charged for operating certificates, except those covering portable equipment, which are the same as those for installation permits.

A graduated scale of fees, depending on capacity, is prescribed for steam and hot-water heating boilers, power boilers, warm air heating furnaces and furnaces other than boiler furnaces, as well as for ovens, kettles, etc., used in industrial processes. Only those pertaining to power boilers will be quoted here; they are as follows:

Less than 10 hp	$10.00
10.1 to 25 hp	15.00
25.1 to 50 hp	25.00
50.1 to 100 hp	35.00
100.1 to 200 hp	50.00
200.1 to 400 hp	75.00
400.1 to 600 hp	100.00
600.1 to 1000 hp	150.00
Over 1000 hp	200.00
Air or steam-air jets for each boiler	10.00

For boilers with integral gas burners, oil burners or stoker, the fee will be $1^1/_2$ times the boiler fee.

A boiler horsepower is figured as equivalent to the evaporation of $34^1/_2$ lb of water per hour from and at 212 F.

No fee shall be payable if the owner of the premises affected be a corporation or association organized and operated exclusively for religious, charitable or educational purposes, and if the premises be used exclusively for such purposes.

Handling and Use of Fuel

Transportation, processing, handling and storing of all fuels shall be conducted in such manner as will not create any public or private nuisance. Where oil burners are being operated with automatic or manual controls, approval must be obtained as to the type and characteristics of the fuel oil used and the methods employed in its utilization.

The Board shall specify the volatile content of the solid fuel that may be consumed in any hand-fired equipment, provided that a fuel shall not be specified whose volatile content is in excess of the

(Continued on page 63)

(*Continued from page 63*)

volatile content of the fuel now being used by any person hand firing when these rules go into effect. Also, no solid fuel shall be burned, imported, stored, sold or delivered for hand firing that does not meet the standard that has been prescribed by the Board.

Furthermore, a fuel shall not be specified for hand firing with a volatile content in excess of 24 per cent on an ash- and moisture-free basis. Any solid fuel with a volatile content in excess of this shall be burned with mechanical fuel-burning equipment only.

All oil burners having a maximum fuel input exceeding 850,000 Btu per hr shall be under the supervision of a licensed oil burner operator, unless evidence is filed with the Board that they are serviced during each 30-day period.

ALTERATIONS

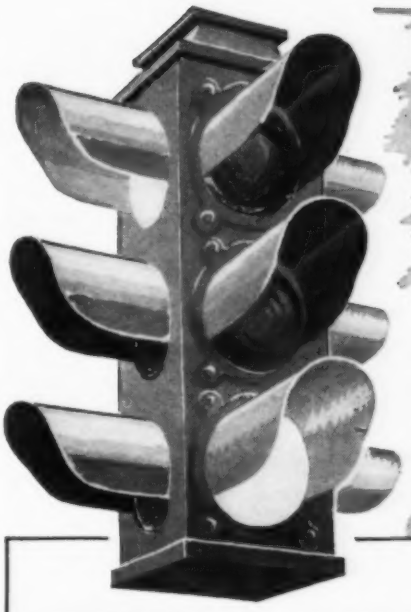
Repairs or replacements, adjustments, or maintenance work may be performed without a permit if the character of the work conforms with the definition of minor alterations, which are classed as those involving no change as to furnace design, plant capacity, type of fuel burned or method of combustion.

Emergency repairs or replacement work, outside the scope of minor alterations, may be made prior to the application for and issuance of a permit, if delay in doing such work might result in danger to life or property, or to the supply of essential services; provided, however, that in every such case an application for a permit shall be filed not later than within 48 hr after the starting of such repair or replacement work.

Any person who refuses to comply with or assists in the violation of any of the provisions of these rules and regulations, or who in any manner hinders, obstructs, delays, resists or attempts to interfere with the Director or the personnel of the Bureau of Smoke Control in the performance of any duty herein enjoined, shall be subject to the fines and penalties provided in Section D26-1.0 of Chapter 26 of the Administration Code of the City of New York.

J. N. Hunter

J. Nelson Hunter, purchasing agent of Combustion Engineering Corporation, Ltd., of Canada, passed away suddenly on August 24 at the age of 59. A native of Northern Ireland, he came to the United States in 1913 and two years later became associated with Combustion Engineering Company in New York, later spending two years with the Royal Flying Corps during World War I. When the Canadian Company was formed in 1923, he was transferred to Toronto as chief draftsman, and subsequently to Montreal as purchasing agent where he was widely known to Canadian engineers.



DRAFT FANS

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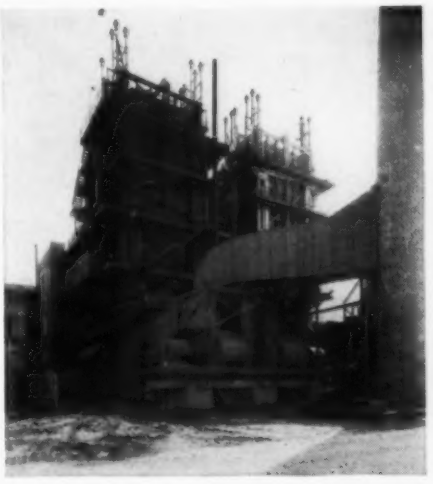
GREEN FANS . . . Used by Many Leading Utilities

One significant fact about Green Fan Installations at the New Orleans Public Service Plant is that two different boiler manufacturers were involved . . . two different types of boilers but Green Draft Fans for all three boilers. Each boiler has two Green Induced Draft Fans and one Green Forced Draft Fan.

When a concern has specialized on an important piece of power plant equipment for many years, that firm is rightly called the "authority" on the subject. This is the position of Green Fuel Economizer Co. in the field of mechanical draft fans. The name Green is synonymous with Draft Fans highly acceptable to industry.



The Line of Green Induced and Forced Draft Fans includes many types in many sizes which are described in Bulletin No. 168. We shall be glad to discuss your fan requirements with your own engineers, with your consulting engineers and with the boiler manufacturer of your choice.

THE GREEN *Fuel Economizer* COMPANY INC.

BEACON 3, NEW YORK

ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

HAGAN controls and meters

AT ARTLOOM CARPET COMPANY, Inc.

When Artloom Carpet Company, Inc., Philadelphia rug manufacturers, needed increased factory space a few years ago, they decided to eliminate a stand-by boiler room. This was made practicable by modernization and expansion of the regular power plant.

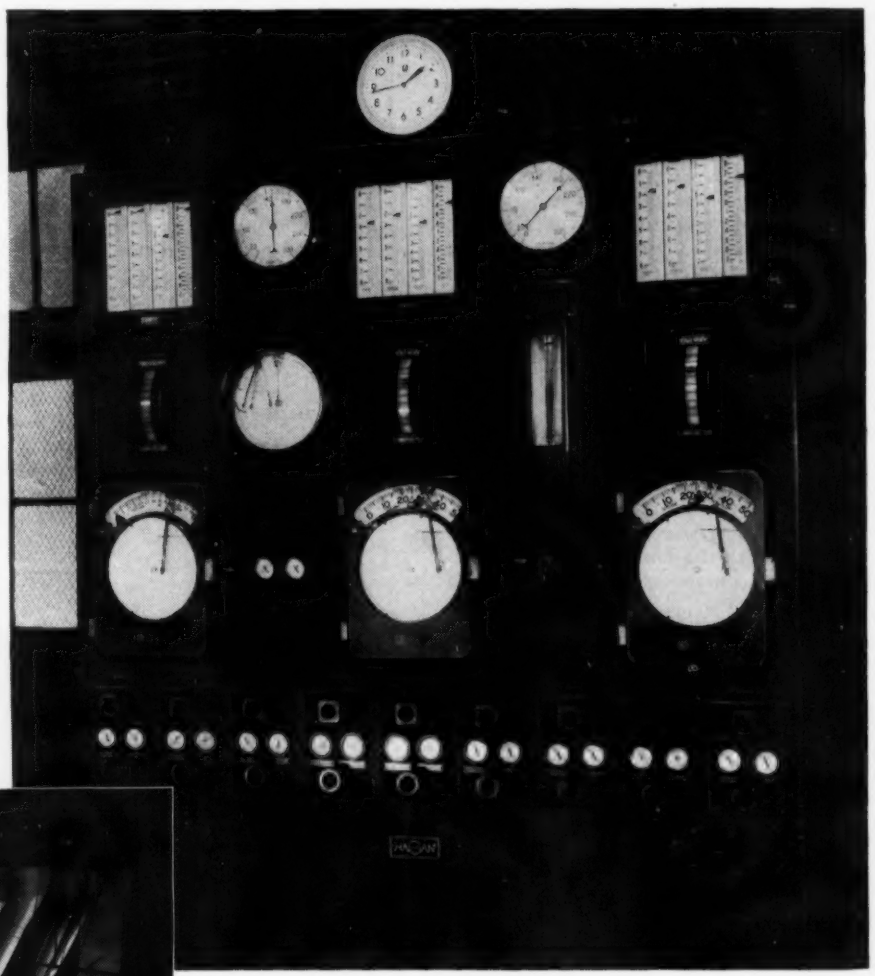
The first step in the program was the purchase of a new boiler and necessary auxiliaries—and the immediate installation of Hagan combustion controls and Hagan Ring Balance instruments on the two old boilers so as to bring up their efficiency. Provision was made at the same time for centralized control of all boilers.

The Ring Balance Boiler Meters are of the indicating and recording type. Integrators automatically total steam flow from each boiler. A third pen records stack temperature.

On all three boilers, stokers and fans are turbine driven. Combustion conditions are regulated by direct speed control of stokers and fans. Rated capacity of the old boilers is 50,000 pounds per hour, of the new boiler 65,000 pounds per hour. There are load swings of as much as 30,000 to 35,000 pounds per boiler from the low at night to the peak demand when the dye shift begins work in the morning.

The controls and meters have given complete satisfaction, and have required no attention except routine maintenance since they were placed in operation.

For full information on Hagan Controls and Hagan Ring Balance Flow Meters, call the nearest Hagan representative or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.



Below: Present boiler room at Artloom Carpet Company, Inc., Philadelphia. Modernization was planned and directed by Louis T. Klauder and Associates, consulting engineers. Otto Helbert, master mechanic, and Arthur Ingram, chief engineer, are in charge of the plant.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

Boiler Inspection in Central and South America

In reviewing reports of accidents and fatalities in Mexico, Central and South America, the number of serious injuries and loss of life due to boiler failures is appalling, according to Captain J. N. Parrott, executive manager of the Inter-American Safety Council. While statistical reports for 1949 are not yet complete, indications are that they may exceed those of 1948. Proper boiler operation, repairs and periodic inspections would eliminate most of these serious injuries and fatalities.

During a recent trip through Latin America, Captain Parrott reports, a boiler situated near the corner of a main thoroughfare and only a short distance from a public school, exploded at noon while many children were passing. The explosion took the lives of twelve children, as well as that of the boiler operator. The tragedy could have been avoided had the operator been properly trained, for investigation revealed that the water gage had broken and that he had inserted wooden pegs at each end of the fitting.

In another Central American city, a boiler operator was annoyed by the blowing of the safety valve, and to eliminate the noise he had tied it down with a piece of baling wire; then left the boiler room to get coffee. While he was away the boiler exploded and caused the death of four men working nearby.

Lack of Inspection Apparent

On this trip many boiler plants were visited and numerous hazardous conditions found. In some instances boiler plates with bolted-on patches were noted and boiler foundations were braced with wooden blocks. In others, firebox linings were broken and firebox doors held in place by pieces of wood; grates were broken and supported from the ashpit by bricks or stones. These conditions indicated lack of inspection and upon calling the management's attention to them, indifference was frequently encountered. Unfortunately, the impression seemed to prevail that once a boiler was installed its operation consisted only of such routine duties as tending fires, checking pressure, with little thought being given to proper inspection.

"In many of our sister republics," says Captain Parrott, "there has been little or no enforcement of boiler inspections and in many instances where inspections are required by law, it was apparent that some of the inspectors were not fully qualified or did not make thorough inspections and report conditions to the proper municipal or governmental authorities."

Adoption of Boiler Codes Urged

The Inter-American Safety Council recently assisted the American Society of Mechanical Engineers in translating its Boiler Code and this is being urged, as a guide, for boiler codes in those countries where no such regulations exist. The Council has also prepared cards for the use of operators in keeping maintenance records, and other of large size containing operating instructions for hanging in boiler rooms.

STRENGTH that FORESTALLS ATTACK

Adequate defense may well mean strength unchallenged.

In boiler operation, scientific feedwater control defies corrosion's threat of aggression. Yet a factor-of-safety allowance in boiler design admits the possibility of sneak-attack penetration of even this powerful defense. Only *total preparedness* — utilization of *every* recognized means of preventing such attack — can assure security in any degree.

You get such total preparedness when APEXIOR NUMBER 1 brush-applied surfacing builds into boiler drums and tubes a margin for error that permits steel to take in stride any deviation from straight-line performance. APEXIOR becomes your first line of defense, holding losses to an expendable maintenance item — never exposing steel to risks that are always costly even though calculated.

Where ideal conditions make few police-action demands on a protective coating, APEXIOR's positive contributions to boiler performance are yours for an extended service life. Smooth APEXIORized metal repels deposits to keep heat transfer high and distribution uniform . . . to improve evaporation and circulation . . . to assure less costly cleaning, mechanical or chemical, for APEXIOR is inert to all acid-cleaning solutions.

8-page Bulletin 1530 tells you more about boiler APEXIORizing. Let us send you a copy.

Unretouched photograph showing APEXIORized boiler steel as it came out of service after 14 months operation at 1250 pounds pressure

MAINTENANCE FOR METAL

THE DAMPNEY COMPANY OF AMERICA

HYDE PARK, BOSTON 36, MASS.

111—1

It was 1912—and the Girl Scouts of America were founded by Mrs. Juliette Low—when we introduced "Flexitallic", the *original* Spiral-Wound Gasket, and opened to Industry new fields of opportunity in the confining of fluids at high pressures and temperatures.

ENGINEERED TO AN EXACT STANDARD OF PERFORMANCE

Flexitallic Spiral-Wound Gaskets range in size from one-half inch to 104 inches . . . In price from a few pennies to hundreds of dollars . . . In application to pressures of 10 thousand pounds . . . For temperatures to 1800°F.

Each Flexitallic Gasket is engineered from the ground up for operation at specified temperatures and specified pressures—and to meet particular conditions of thermal and physical shock, corrosion, vibration and unusual joint stress.

The basic Flexitallic principle—the spiral winding of V-shaped spring-like metal plies alternating with plies of filler—lends itself naturally to almost unlimited variation.

The physical and chemical properties of the several metals, the different types of filler, the relation of filler to metal in the winding—all these are *variables* in the hands of the Flexitallic engineer.

Using the most precise instruments for determination of yield values, resilience and gasket density, the Flexitallic engineer builds each Flexitallic Gasket to an *exact standard of performance.*

Many Flexitallic Gaskets — originally designed as "specials" for oil refineries, chemical industries, power plants, shipyards, ship-operating companies — are now "standard" gaskets in the Flexitallic line.

If safe sealing is of serious concern to you, give us these facts on your gasketing requirements: (1) Fluid to be confined; (2) Type of Flange and dimensions; (3) Operating pressures and temperatures; (4) Bolting data.

In return we will send you a genuine Flexitallic Gasket. Test it severely—in your laboratory or on the job. Results will show you why most industries in the high-pressure, high-temperature fields are standardized on Flexitallic Spiral-Wound Gaskets.

FLEXITALLIC GASKET COMPANY
Eighth and Bailey Streets, Camden 2, N. J., U.S.A.

The name "Flexitallic" is the registered trade mark identifying the *original* (patented) Spiral-Wound Gasket. Now—for your protection and ours—this trade mark FLEXITALLIC is stamped into the outer ply of every *genuine* Flexitallic Gasket. Your guarantee of quality.

Flexitallic®
SPIRAL-WOUND GASKETS

New Books

Any of these may be secured by writing Combustion Publishing Company, 200 Madison Avenue, New York 16, N. Y.

Coal

By Dr. H. J. Rose

This pamphlet of 50 pages is reprinted from the Encyclopedia of Chemical Technology and contains a wealth of general information and data concerning coal, such as the average engineer will find useful for reference. This includes its physical and chemical properties, origin and petrography, reserves, a brief discussion of mining, and preparation, classification, testing factors in selection and consumption statistics.

The author is vice president and director of research of Bituminous Coal Research, Inc., and a widely known authority on the subject of coal. The pamphlet is priced at $1.

Effects of Atomic Weapons

This timely 456-page book, prepared by the Atomic Energy Commission and the Department of National Defense, covers the principles of an atomic explosion, descriptions and effects of air bursts, underwater and underground bursts, initial and residual radiations, contamination and decontamination, effects on people and their protection, and essential disaster facilities.

The text is profusely illustrated by official photographs of damage at Nagasaki and Hiroshima, as well as of ships at Bikini.

Aside from providing most fascinating non-technical reading on a subject now uppermost in the public mind but little understood outside of scientific circles, the book should serve a most essential purpose at this time of uncertainty in disseminating information on what might be expected and how best to provide protection in the event of an atomic bomb attack.

Bound in cloth, the book sells for $3.

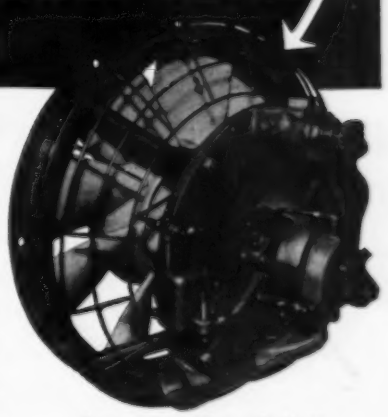
Applied Thermodynamics Problems for Engineers

By W. J. Peck and A. J. Richmond

Engineers interested in reviewing thermodynamics to prepare for examinations for professional licenses will find this British book quite helpful. It presents a representative selection of fully worked examples along with explanatory material which enables the one who is reviewing to follow the solutions in a logical manner. Since the symbols and units employed are those common in Great Britain, some care must be exercised to make allowances for differences in conventional notation and values of units.

Among the topics covered by the problems and solutions are gas laws, compressors, internal-combustion engines, combustion, steam and gas turbines, properties of steam, steam cycles, refrigeration, and heat transfer. Some of the questions are taken from examinations given for

Wing Turbine Blower Saves Floor Space, too



Besides furnishing forced draft with precise control, the Wing Turbine Blower contributes to the cost-saving features of the B & W Integral Furnace Boiler, illustrated above, by saving valuable floor space, avoiding duct work and large space requirements. It is also quiet and efficient in operation.

A copy of Wing Bulletin No. SW-50 on Wing Blowers and Turbines will be sent on request.

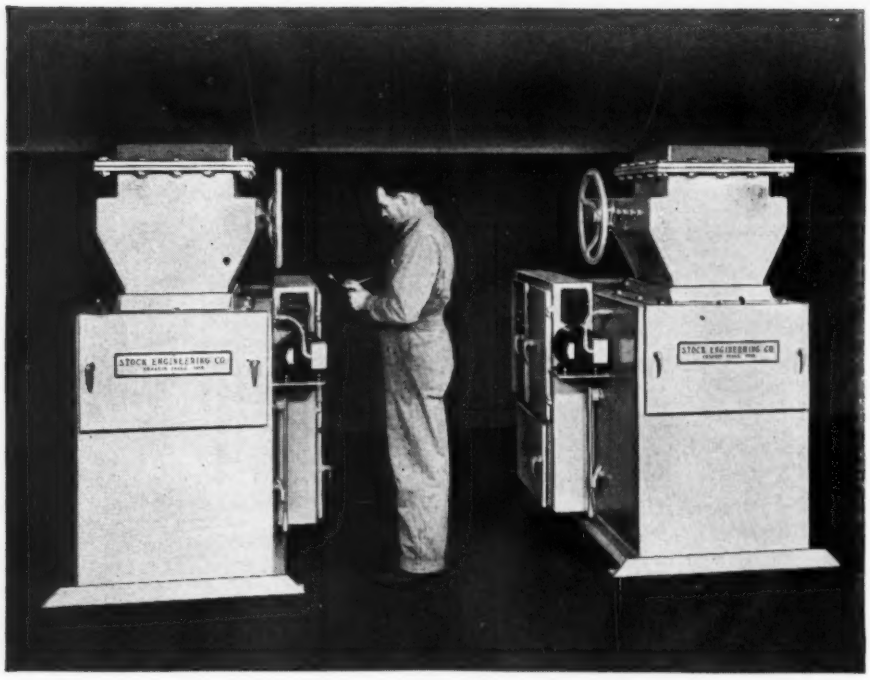
Wing

AXIAL FLOW BLOWERS

L. J. Wing Mfg. Co.

54 Vreeland Mills Road
Linden, N. J.

Canadian Factory: Montreal



SMALL SPACE REQUIRED FOR

S-E-CO. COAL SCALES

S-E-Co. Coal Scales are designed with the idea of making them fit into the very minimum of space. For example, the overall height of the 200 pound scale, rated at 10 tons per hour, is 3′-9″. The overall width and the overall length are also small.

If you are faced with the problem of fitting a coal scale into a plant arrangement that provides but little space for the coal scale, the S-E-Co. Scale is the machine for you.

Write for dimension prints.

STOCK EQUIPMENT COMPANY
715C Hanna Building ★ Cleveland 15, Ohio

associate membership in British engineering societies and provide an idea of the rigorous qualifications for admission to those societies.

The book should also prove useful because of the inclusion of hints and intermediate and final answers for unworked examples appearing at the end of each chapter. It contains 344 pages and sells for $4.

Leitfaden der Technischen Warmelehre nebst Anwendungsbeispielen (A Basic Textbook of Thermodynamics including Practical Examples)

By H. Richter

For the design and operating engineer having responsibility in power plants and for refrigeration equipment this German-language book may serve as a guide to the basic theory of heat and the thermodynamics of gaseous and vaporous substances.

The first part of the book covers mathematical and physical theory. It is followed by a section which includes examples of practical applications of the theory. This arrangement makes the text ideal for home study in addition to its possible use as a text in technical schools. It is also suitable for review purposes.

There are a large number of practical examples illustrating typical applications of thermodynamic theory, and many of the solutions are worked out in full. The book provides simplified methods for solving problems graphically. Units throughout the book are in the metric system. There are 617 pages and the book sells for $8.65.

Depreciation

By E. L. Grant and P. T. Norton, Jr.

At points where the fields of engineering and accounting overlap there are apt to be misunderstandings derived from lack of knowledge of respective points of view. This book covers an important and often controversial area of policy making, namely, financial practices relating to the ever decreasing values of installed equipment. It is intended to serve as a useful manual for those responsible for the accounting treatment of depreciation, to discuss the various types of business decisions concerned with declining value of physical assets, and to exert influence on the income tax and accounting treatment of depreciation in the United States.

There are four parts to the book. Part I, Some Fundamental Concepts, deals with the importance of depreciation and the reasons for decrease in value and property retirement. Part II, The Treatment of Depreciation for Accounting and Income Tax Purposes, concerns itself with basic concepts of orthodox depreciation accounting, straight-line depreciation accounting, fixed property records, and treatment of depreciation in federal income taxes. Of special interest to those interested in problems of steam plant re-

placement is Part III—Some Business Problems Related to Depreciation Accounting. In this part, engineering economy studies are discussed, and analyses are made of problems caused by price-level changes and means of financing replacement of assets; some of the limitations of depreciation accounting as a guide to business decisions are also noted. Part IV, The Public Viewpoint, deals largely with proposals for improving the accounting and income tax treatment of depreciation, including case studies of technological stagnation based upon experience in Great Britain.

The authors believe that the public interest requires the abandonment of the straight-line method based on the best evidence of full service life as a standard of reasonablness of depreciation rates, and the substitution of one or more other standards allowing a more rapid write-off in the early years. "The practical certainty of continued high income tax rates for many years into the future makes it imperative that there be a liberalization of the income tax treatment of depreciation in the United States. Otherwise, the continued combination of high income tax rates and low allowable depreciation rates [might] exert a strong influence in the direction of technological stagnation."

Appendices to the book include excerpts from the Internal Revenue Code and Income Tax Regulations, a table of composite lives for various industries, selected court decisions on income tax aspects of depreciation, and interest tables. There are 472 pages, 6×9 in., and the book sells for $5. It should be of special interest to those engaged in utility management.

Data on Corrosion- and Heat-Resistant Steels and Alloys

These new tables of data on the compositions and properties of the wrought corrosion-resistant and heat-resistant chromium and chromium-nickel steels and alloy castings have been assembled by Subcommittee I on Classification of Data, of the American Society for Testing Materials Committee A-10 on Iron-Chromium-Nickel and Related Alloys.

This publication brings up-to-date a previous compilation on wrought stainless alloys and includes a comprehensive new section devoted to cast alloys. The present classification provides data on those stainless steels that have received the widest commercial usage. The text has been divided into two parts, the first dealing with wrought alloys and the second with cast alloys.

The data for the different steels have been condensed to the simplest form to provide a ready reference for both the maker and user of the steels. Inspection was made of a large amount of data, and those included provide the present representative information on the steels covered, as obtained from both producers and consumers. The pamphlet contains 77 pages and, with heavy paper cover, is priced at $2.50.

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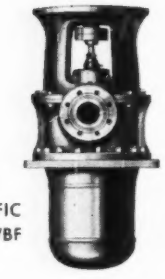

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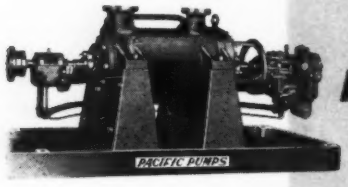

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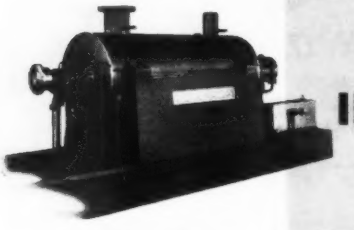

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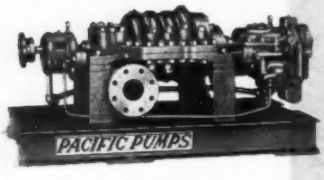

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A.S.M.E.-A.I.M.E. Joint Fuels Meeting

Cleveland will be host on October 24 and 25 to the Thirteenth Annual Joint Fuels Conference of the American Society of Mechanical Engineers Fuel Division and the American Institute of Mining & Metallurgical Engineers Coal Division. All sessions will be at the Hotel Statler.

Eugene D. Benton, general chairman, has announced that the program covers four technical sessions and two luncheon meetings. A high point of the two-day meeting will be the banquet on Tuesday evening at which the Percy Nicholls Award will be presented to Julian E. Tobey, president of Appalachian Coals, Inc. Several other awards will be made for distinguished service to the profession.

The banquet speaker will be Elmer L. Lindseth, president of the Cleveland Electric Illuminating Co., who will talk on "The Kilowatt-Hour in War and Peace."

The opening session on Tuesday morning will be a panel discussion on "Coal Characteristics Affecting Burning Equipment." The topics will include coal for underfeed stokers, pulverized coal, spreader stokers, chain grate stokers, and cyclone furnaces. C. H. Barnard of Bailey Meter Company, Cleveland, will discuss new developments in gas analyzers for better combustion.

H. G. Dyktor, Commissioner of Air Pollution for the City of Cleveland, will give the luncheon address, "Meet the Smoke Inspector," and will be introduced by Elmer R. Kaiser, Chairman of the A.S.M.E. Fuels Division.

The Tuesday afternoon session will consist of two papers, one by H. A. Baldwin of General Motors Corp., and the other by Marshall Pease, Jr., and R. J. Brendon of The Detroit Edison Company, Detroit. They will discuss the present fuel situation with respect to coal and competing fuels, their utilization and fuel procurement.

The Wednesday morning session will feature two papers on coal sampling. B. A. Landry of Battelle and W. W. Anderson of Commercial Testing & Engineering Co. will present their paper on "Coal Sampling by Large Increment Weights." Mr. Landry and A. L. Bailey of the Bureau of Mines will present a paper on "The Effect of Coal Size on the Sampling of Coal for Float and Sink Tests." These papers will be of interest to both coal preparation engineers and coal consumers.

C. F. Hardy, Chairman of the A.I.M.E. Coal Division, will introduce George E. Whitwell of the Philadelphia Electric Co. at the Wednesday luncheon. Mr. Whitwell will speak on "The Competitive Aspects of the Electric Utility Business."

The afternoon session of the second day will consist of three papers—"Frothing Characteristics of Pine Oils in Flotation," and "Dewatering of Fine Coal," respectively, by Messrs. Sun and Wright of Pennsylvania State College, and "An Investigation of the Abrasiveness of Coal and Its Associated Impurities," by Messrs. Yancey, Geer and Price of the Northwest Experimentation Station, U.S. Bureau of Mines.

New Catalogs and Bulletins

Any of these may be secured by writing Combustion Publishing Company, 200 Madison Avenue, New York 16, N. Y.

Centrifugal Pumps

Economical pumping units for a wide variety of uses are cataloged in a new 16-page "Handy Guide to Selection of Centrifugal Pumps" released by Allis-Chalmers Manufacturing Co. Among the types of units indexed in this bulletin are close-coupled, pedestal, double-suction-single-stage, multi-stage, self-priming, fractional-horsepower, coolant and circulating, rubber-lined, axial and mixed-flow pumps. Head capacity charts and tables for various types are given along with data on sizes, capacities and construction features.

pH Electrodes

The complete line of Leeds & Northrup pH electrodes and assemblies for both industrial and laboratory applications is presented in a 28-page catalog, "pH Electrodes, Assemblies, Parts and Accessories." The publication lists the advantages of each type of electrode, and by means of an illustrated double-page spread shows in tabular form each assembly with its components. Glass electrodes for industrial use are shown in detail.

Regulators

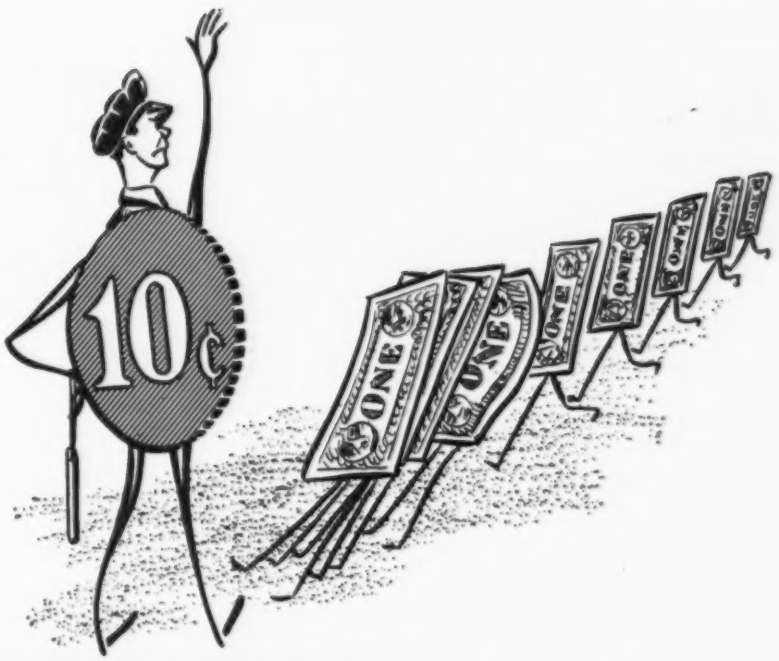
A new 32-page booklet containing useful information about pilot-operated pressure and temperature regulators is available from Spence Engineering Co. Illustrated with photos, charts and tables, it discusses main valves, controls and strainers, gives capacity and flow data, and lists dimensions and weights. Case example problems are cited to help in the selection of the correct size and type regulator for particular applications.

Speed Reducers

Type AT and RT worm-gear speed reducers are described in the 12-page Bulletin No. 130 issued by the Cleveland Worm & Gear Co. Horsepower rating tables provide power transmission capacities for various sizes of worm-gear-reduction units. Another section of the catalog describes construction features of Cleveland worm gears.

Steam Plant Equipment

Yarnall-Waring Company has revised its 12-page condensed catalog on Yarway steam plant equipment. Descriptions and illustrations refer to blow-off valves for low, medium and high pressures, water columns and gages, liquid level indicators and recorders, expansion joints, steam traps, and strainers and spray nozzles.



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BOOKS

1—Steam Power Plants

By Philip J. Potter

503 pages Price $6.50

This addition to the list of college textbooks covering the heat-power field is characterized by an unusually detailed presentation of fundamental theory, without loss of practical attention to the present state of the power plant art. It also ranks among the best-illustrated books of its type, not only from the point of view of the selection of photographs, diagrams and curves, but also as an example of their excellent reproduction.

Following an introductory chapter the author undertakes an exposition of Flow of Fluids, a chapter which includes an especially intelligible discussion of viscosity along with practical data on piping. Then follow chapters on Pumps, Theory of Heat Transfer, Fuels and Combustion, Steam Generators, Boiler Auxiliaries, Heat-Exchangers, Steam Turbines, Steam Engines, Heat Balances and Economics of Steam Power Plants. Each chapter includes selected problems of the type encountered in power plant design and there is an appendix which contains two design problems on industrial power plant layouts along with typical dimensions and performance curves of representative equipment. The chapter on Steam Generators includes a 16-page account of boiler design, and theoretical considerations relative to steam turbines are discussed in more than usual detail in the chapter on Steam Turbines.

Practicing engineers will find Professor Potter's book a valuable addition to their technical library because it is well written and effectively illustrated.

2—Refresher Notes (Revised)

By John D. Constance

194 pages $8^3/_4 \times 11^1/_4$ Price $4.50

These notes, covering hydraulics, thermodynamics and machine design, form the basis of a tested course the author has given for several years past under the educational auspices of the Metropolitan Section A.S.M.E. Presenting the fundamental concepts, methods and applications of these subjects, the text is arranged as a review for those who have previously studied the subjects, and particularly to aid those who contemplate taking the examination for a professional engineer's license. In fact, most of the problems and their solutions are based on such past examination questions.

The book is in loose-leaf form, with paper cover, and the notes are offset. This revised edition contains a Mollier chart.

Each copy of the book will include solutions to a late New York State Professional Engineers' License examination covering the basic engineering sciences.

3—Fundamentals of Power Plant Engineering

By George E. Remp

347 pages $5^1/_2 \times 8^1/_2$ Price $6.50

The author, who is assistant professor of mechanical engineering at the University of Florida, has adopted a sequence of presentation that is quite different from that of most textbooks. Starting with a study of load curves, followed by the economics of power production, vapor power cycles and heat balances, he then proceeds to consideration of the various items of equipment that enter into a power plant. This logical approach simulates that which the student is likely to encounter later in practice. The treatment assumes familiarity with the fundamentals of engineering thermodynamics but is not too technical.

Numerous problems are included as well as their solutions, and the text is adequately illustrated. The appendix contains much useful data and a reproduction of the Combustion Engineering-Superheater steam tables.

4—Steam Turbines and Their Cycles

By J. Kenneth Salisbury

645 pages 6×9 Price $9.00

This subject has been dealt with in many texts, usually as part of textbooks written by professors with a view to acquainting undergraduate students with the fundamentals of power generation; but such information is obviously quite general. Of the very few authoritative treatises on the subject of steam turbines, such as the classic work of Stodola, most are now more or less out of date. In view of this the present contribution by Mr. Salisbury meets a widely felt need by providing an up-to-date, authoritative and practical volume that should be most useful to the practicing engineer.

A brief review of the contents reveals, among others, chapters on thermodynamics, power plant cycles, flow of liquids, turbine design and characteristics, cycle analysis, with particular reference to the regenerative cycle and heat balance, heater arrangements, design details, estimating heat rates, and various other factors affecting performance. The effect of many variables on plant performance is discussed at length. An appendix contains data often required by the application engineer in calculating heat balance.

5—Sales Engineering Second Edition

By Bernard Lester

226 pages Price $3.00

Perhaps one of the least understood phases of engineering is that dealing with the sale of machinery, equipment and technical products. With the ever increasing use of "high-pressure" selling for consumer goods, it is natural to assume that industrial equipment is sold in a similar manner. However, Mr. Lester carefully differentiates methods applicable to each and points out that in sales engineering a successful sale is both a profitable sale to the supplier and a profitable purchase to the buyer.

There are five parts to the book: The Field of Sales Engineering, Buying and Selling, The Sales Engineer in Action, Selling to Those Who Buy for Resale and The Training and Development of the Sales Engineer.

The effectiveness of the text is enhanced by the skillful use of interesting case studies of actual industrial selling problems. Anyone who has been concerned with either buying or selling a major piece of power-plant equipment will recognize the practical usefulness and wisdom of the suggestions made in the case studies.

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Electric Output Still Climbing

August showed the highest monthly production on record by the electric utilities, according to a report just issued by the Federal Power Commission. The total output of 28,869,266,000 kwhr represented an increase of 6.9 per cent over that of August 1949. Fuel-burning plants produced over 70 per cent of the total. Electrical output for the 12 months ending August 31 was 311,332,454,000 kwhr, which represented an increase of 7.3 per cent over the preceding 12 months.

As of August 31, this year, the reported total installed capacity of electric utilities was 66,345,767 kw, and the combined utility and industrial generating capacity exceeded 80 million kilowatts. The combined electric output for the month was close to 34 billion kilowatt-hours.

With reference to fuel consumption, in August the report lists 8,117,852 tons of coal, 6,042,684 bbl of oil and 67,335,869,000 cu ft of natural gas. This gas consumption was the highest on record. The oil consumption was also above that of August 1949 by 11.1 per cent.

Stocks of coal on hand, as of September first, exceeded 27 million tons, a figure somewhat less than that of a year ago, but substantially above those reported a month previous. Based upon the August rate of coal consumption, the stocks on hand at electric utility plants as of September 1 were sufficient to last 105 days.

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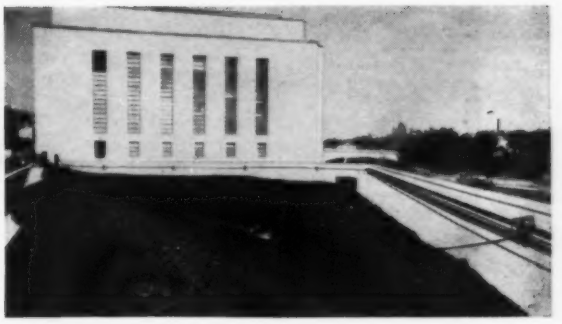

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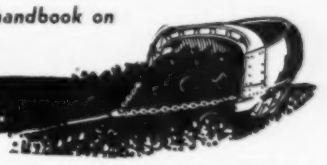
TYPICAL EXAMPLE—Pictured above is the Sauerman installation at the West Central Heating plant, Washington, D. C. This new plant, furnishing steam to about 125 public buildings, needed a 16,000-ton stockpile and had only a small triangular ground area available for the purpose. Moreover, being in a residential section of the nation's capitol, it was essential to use a method of handling the coal that would not create undue noise and dirt. All requirements were well met with a 100 h.p. Sauerman scraper machine equipped with a trolley and monorail at the tail end. The monorail runs along the top of a retaining wall which encloses the storage area. The operator is stationed in a cab on the side of the plant, giving him a full view of the stockpile and hopper while he manipulates the switches controlling the scraper hoist and the monorail winch.

The new Sauerman Coal Storage Catalog is a useful handbook on the subject of storing coal. Ask for Catalog D. It is free.



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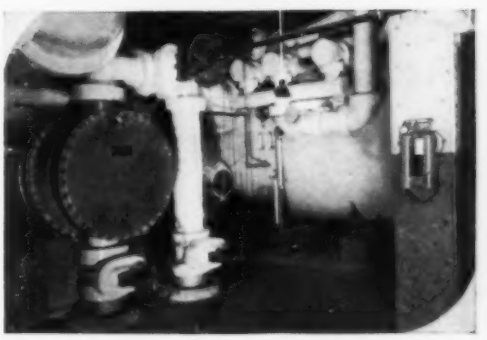

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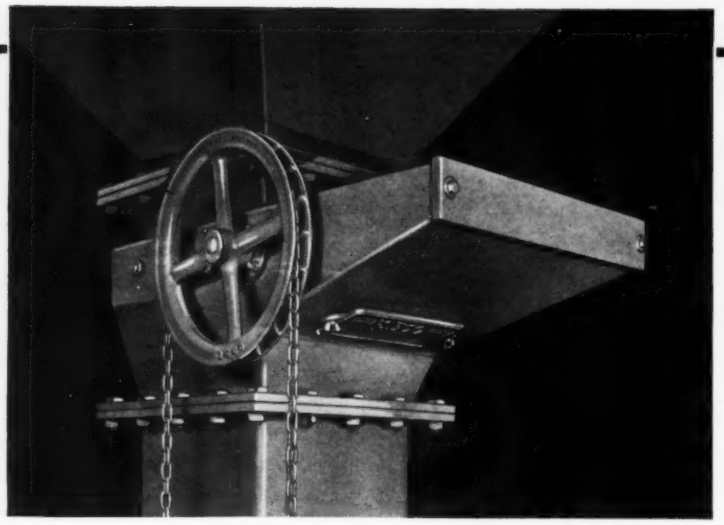

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Gas Turbine Performance Reported from Abroad

The performance of a number of gas turbine sets of Brown Boveri design is reported in a recent issue of *The Brown Boveri Review* (Vol. xxxvii, Nos. 1, 2 and 3).

The largest of these installations is the Beznau Station of the Nordostschweizerishe Kraftwerke at Baden, which has a total capacity of 40,000 kw in two units, one of 13,000 kw and the other of 27,000 kw capacity. These went into service, respectively, in January 1948 and February 1949, and up to the end of 1949 had produced over 65 million kilowatt-hours. The plant supplements a hydropower system and operates principally during the winter months. During that year's operation, some difficulty was encountered with deposits in the air passages but this was later rectified.

Similar trouble was encountered and remedied with the 10,000-kw unit installed in November 1949 at the Santa Rosa power station of the Empresas Electricas Asociadas, Lima, Peru.

Other installations mentioned were a 4000-kw unit in the Chimbote Station of the Corporacíon Peruana del Santa S. A., Lima, also installed last November; two 1650-kw units in the Pertigalete Station of the Cia Anónima Venezulana de Cementos at Caracas; and a 1200-kw unit more recently installed in Alexandria, Egypt.

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CROZER — Genuine Pocahontas from McDowell County, W. Va., on the Norfolk & Western Railway.

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